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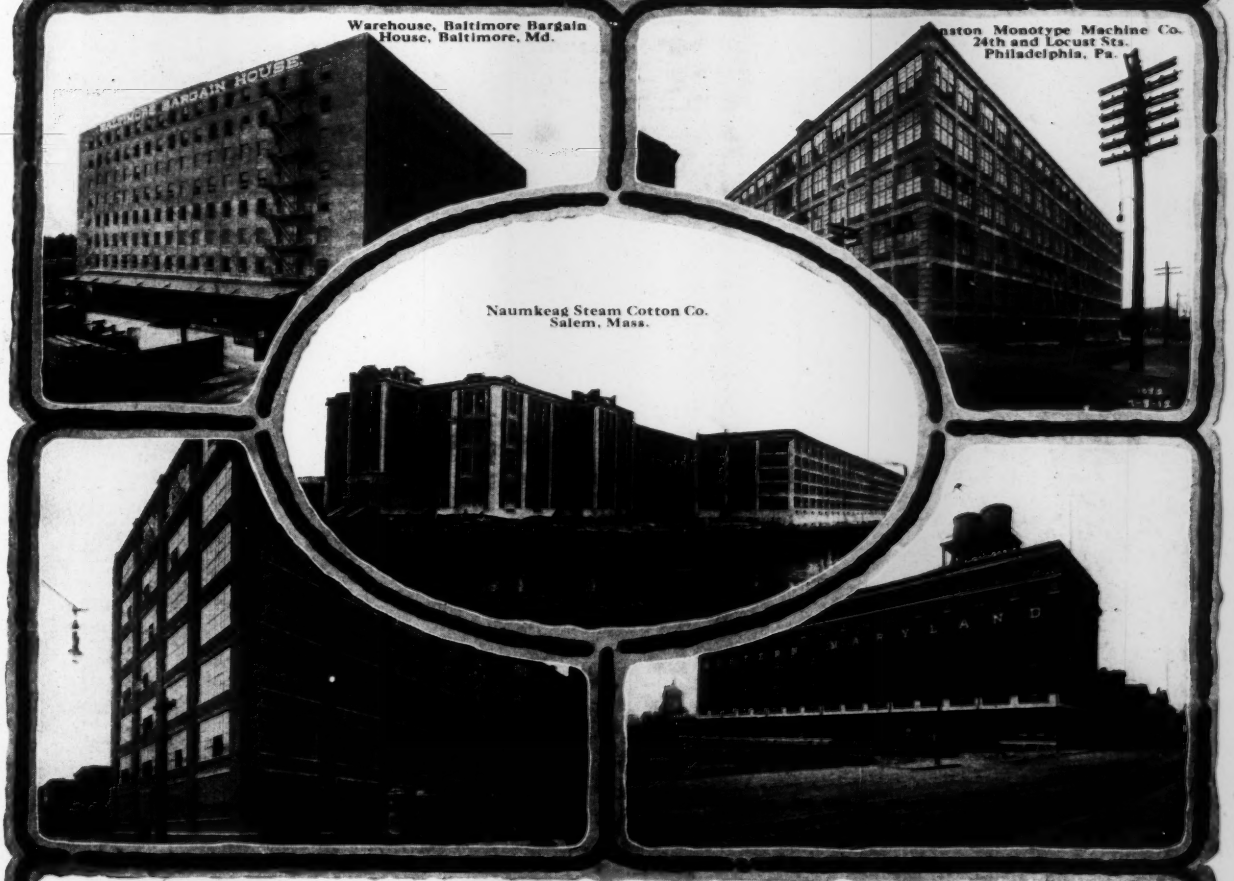

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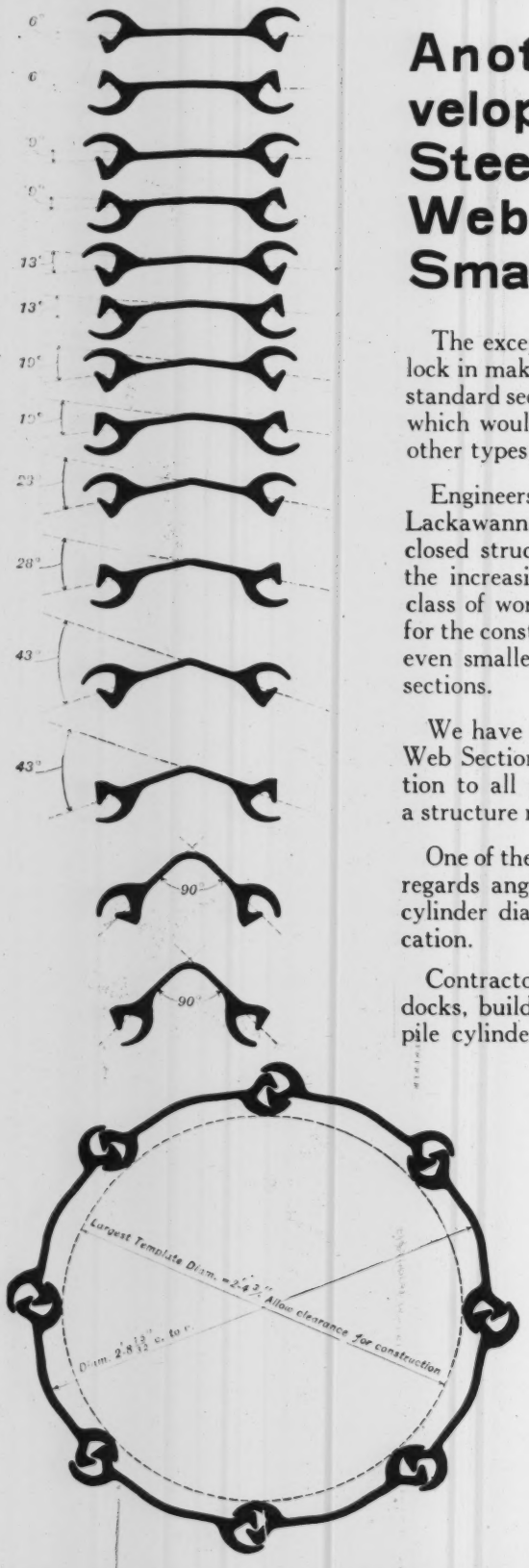

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Engineering News

VOLUME 76 SEPTEMBER 28, 1916 NUMBER 13

Types of Dump-Cars Used on Construction Work--I

SYNOPSIS—A review of different types of dump-cars, for the engineer, the contractor, the job superintendent and the supplyman, in two installments. In this—the first—are considered small hopper cars and high-body tilting cars. The second article will cover flat-cars and unloader plows; gondolas having side doors or drop bottom; center-dumps and side-doors and combinations of both.

In most kinds of construction work there is involved the handling of material by cars. It may be the delivery of a small amount of gravel to a concrete mixer, or the removal and disposal of a great yardage of excavation.

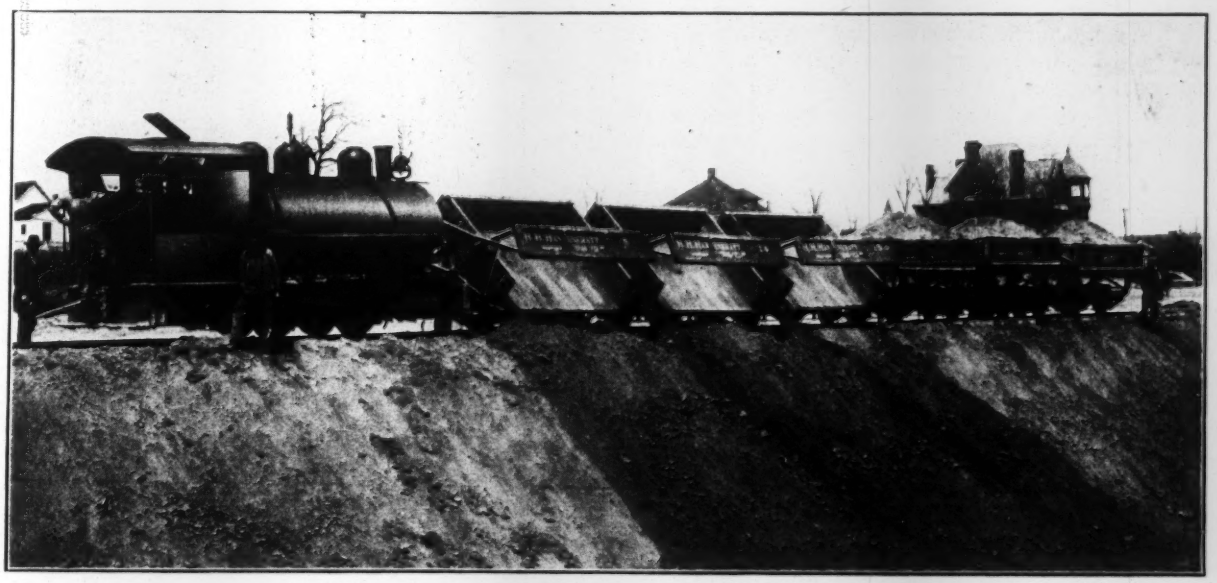


FIG. 1. TRAIN OF 4-YD. SIDE-DUMP CARS
Western Wheeled Scraper Co., Aurora, Ill., builder

It includes such service as the transportation of raw material (such as stone, sand and gravel for road or concrete work), the distribution of concrete, the distribution of track ballast or filling, the removal of excavated material (serving steam shovels or other machines), and the placing of such material to form new fills or widen banks, levees, etc. The field covers work done by contractors and by railway or other company forces, and it includes maintenance and improvement work as well as new construction. The cars employed in such service range from ½ yd. to 40 yd. in capacity and include a variety of forms. Some have movable bodies that dump by tilting, others have fixed bodies with bottom or side doors for discharging, and still others are unloaded by means of traveling plows.

In the small steel hopper car the body is a deep V-shaped tilting hopper, swung low between vertical standards or end frames on the main frames. They are built in sizes of ⅔-yd. to 2-yd. capacity and for tracks of 20- to 30-in. gage, but the smaller cars on tracks of 24-in. gage are those in most general use. These cars are entirely of steel, and they are operated usually on light portable track, with steel rails and ties, built up in sections for convenient handling and placing.

The body is not carried in fixed trunnion bearings, but is so supported as to have a lateral motion in dumping, in order to deliver its contents clear of the track. Fig. 2 shows a car of this type, built by the Orenstein-Arthur Koppel Co., of Koppel, Penn. On each end of the body is a horizontal shelf angle that rests on the curved top of the end frame. In other designs curved rockers on the ends of the body ride on horizontal members of the end frames. In any case the body rolls to the side of the frame as it is dumped.

These cars are used largely in the construction of foundations and large buildings and in other jobs having limited area and close concentration of plant. There they are employed especially for handling material and distributing

concrete, and are particularly adapted for the latter purpose, as there is no chance for leakage. On such work they are usually pushed by hand or operated on inclines by cable hoists. The center of gravity is low, whether the car be loaded or empty.

The steel hopper cars are selected frequently for tunneling and similar work. A specially extensive field at the present time is on highway construction, where they distribute material from the railway siding, or other base of supplies, to the work. They are suitable also for excavation, especially where the total yardage is not great and the amount at any one point is so small, or the cut so shallow, that hand shoveling is employed. The cars, being low, are easily loaded by hand and may be partly tilted to facilitate such loading. They are used to some extent with steam shovels. Besides being used in construction work, the cars are often employed at gravel pits and quarries.

For hauls up to 300 or 500 ft. animal traction may be employed, with trains of five or six cars, according to the size of the car and the grade of the line. For longer hauls locomotive traction is economical. Steam, oil, gasoline and electric locomotives are used and are superseding animal power to a large extent, except on very small jobs.

The portable track is usually in 15-ft. lengths, with the rails bolted or riveted to steel ties 3 ft. apart. The sections may be connected by splice bars, permanently attached to one end of each section, or by special shoe joints. A 15-ft. section of 24-in. track with 20-lb. rails will weigh about 270 lb. Curves, switches, turntables, etc., are made in special sections. Occasionally the rails are spiked to small wooden ties. Care should be taken to have the track well laid and bedded and maintained in good condition.

These small cars are of special advantage for construction work where the equipment must be transported to a considerable distance from the nearest railway point, as the units are easily handled on wagons by teams. Where they are to be operated as a connection between the railway and the work, the portable track is of course laid in advance. These cars, although much in favor with contractors, are rarely adopted by railways, as they constitute a special equipment for which there is only occasional requirement and which is not adaptable to other purposes than a special kind of construction.

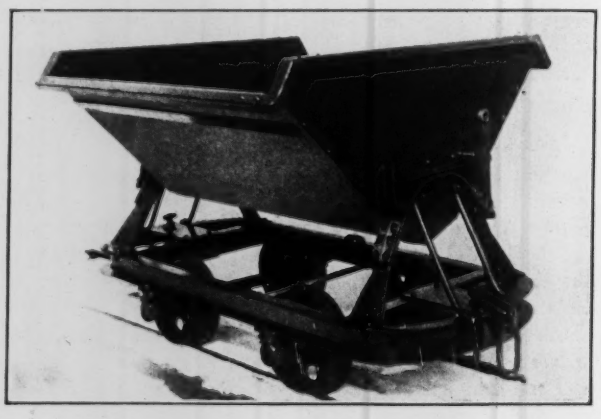


FIG. 2. A 1-YD. STEEL HOPPER DUMP-CAR
Orenstein-Arthur Koppel Co., Koppel, Penn., builder

Cars of this type and of the next type mentioned, with capacities of 1 to 4 yd., present special advantages for widening railway cuts and fills, as their small size enables them to be operated along the right-of-way. Thus they can be run adjacent to and outside of the main tracks without causing any interference with traffic. On small jobs of this kind, with hand or machine loading, the cars may be operated by animal power. Where narrow cuts are to be widened by steam-shovel work, the narrow-gage cars may be used first in widening the cut sufficiently to permit laying a standard-gage loading track, thus avoiding all use of the main track for construction trains.

Some railways provide their roadmasters with a few of these cars to aid in cleaning cuts and ditches, where the work is too small or the traffic too heavy for a regular ditcher and work train on the main track.

Small High-Body Tilting Cars

In these cars the body is a rectangular and relatively shallow box supported above the frames and tilting to either side. The sides (or doors) are usually independent of the body proper and are carried by a system of levers so arranged that, as the body tilts downward, the door on that side swings upward. This gives clear passage for boulders, stumps, etc. Fig. 1 shows a train

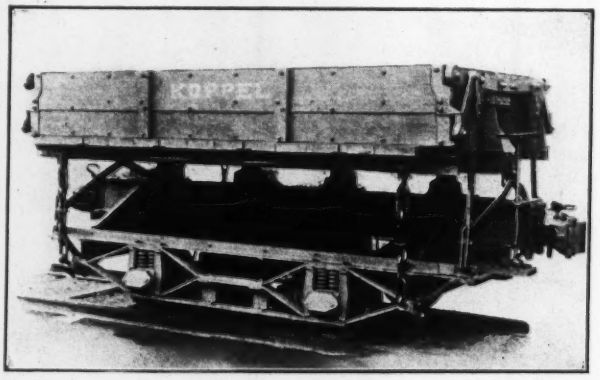


FIG. 3. A 4-YD. SIDE-DUMP CAR
Orenstein-Arthur Koppel Co., Koppel, Penn., builder

of 4-yd. cars of this type built by the Western Wheeled Scraper Co., of Aurora, Ill. The first three cars are dumped, showing the operation of the doors. Fig. 3 is a larger view of a 4-yd. car of this same type, built by the Orenstein-Arthur Koppel Co.

In most of the designs the body simply rocks on fixed central bearings beneath the bottom, but in others the body has a lateral motion as it tilts. While the great majority of the cars are of the side-dumping class, special designs are made to dump at the end or, with a rotating body, to dump either endwise or sidewise. The car body can be so balanced on its supports that one or two men can dump and right a 6-yd. car without difficulty. The body is held in normal position by side chains, which are released for dumping and are coupled up as soon as the body is righted.

Four-wheel cars of this type are built of 1- to 8-yd. capacity and for gages of 24 in. to 4 ft. 8½ in. The 8-yd. size is exceptional, but double-truck 8-yd. cars of narrow gage have a limited application. The 6- and 8-yd. cars are built for both standard and narrow gage, but their use on main-line or running tracks is permissible only for a very

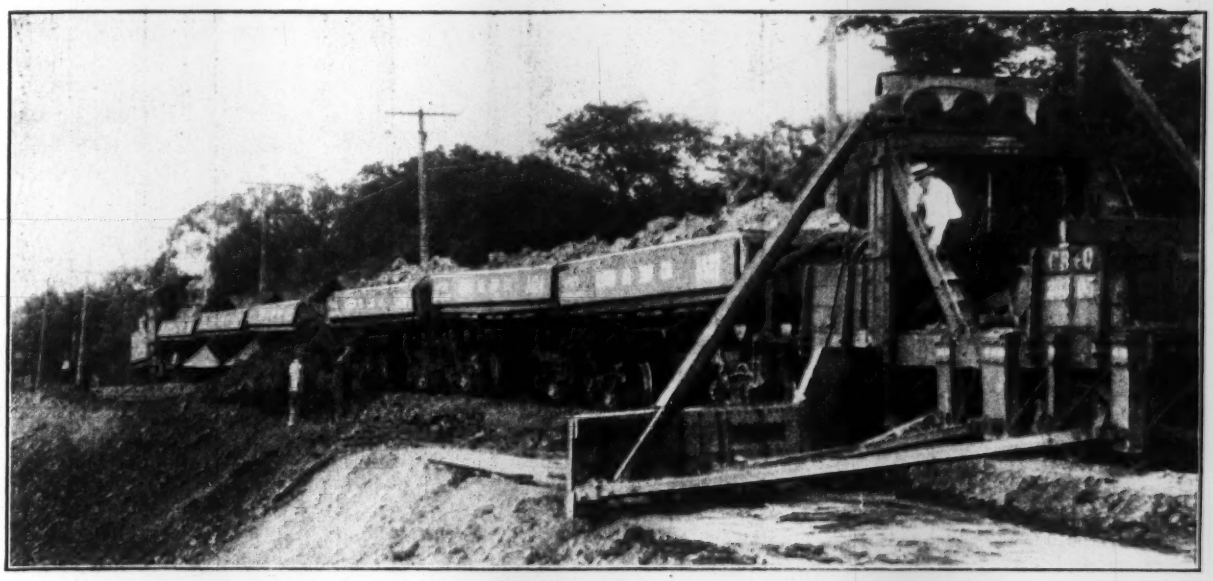


FIG. 4. TRAIN OF 30-YD. AIR-OPERATED SIDE-DUMP CARS WIDENING A FILL
Western Wheeled Scraper Co., Aurora, Ill., builder

short haul. In such case the larger car has an advantage due to its greater capacity. Cars of this class are adopted mainly on work accessible by rail or water transportation, as even in the smallest sizes they are not so easily transported as the small steel hopper cars already mentioned. The cost per ton of material handled would not be much less than with the hopper cars, but the quantity of material handled by one outfit daily would be much greater.

The smaller sizes, 1 to 2 yd., or even 3 yd., are employed particularly on highway and interurban-railway work and also in widening roadbed and for similar service on main-line railways. For highway work they serve not only to remove excavated material, but to deliver sand, gravel and stone.

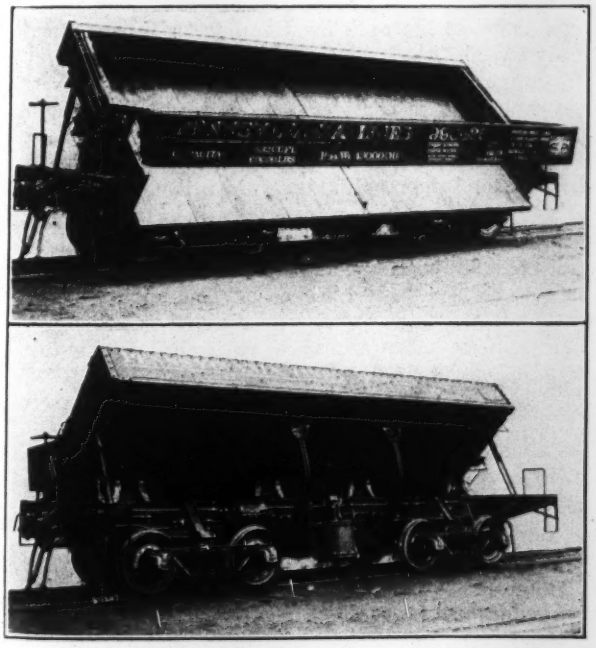


FIG. 5. A 16-YD. AIR-OPERATED SIDE-DUMP CAR WIDENING A FILL
Kilbourne & Jacobs Manufacturing Co., Columbus, Ohio, builder

Cars of 4- and 6-yd. capacity and 30- or 36-in. gage are used extensively by contractors on team-trap work and where the earthwork (in total amount and in depth of cut) is such that a steam shovel can be employed to advantage.

The small narrow-gage cars can be used in widening railway roadbed for additional tracks, where the main track cannot be occupied, as noted previously. In such case there is often room to place the loading track clear of the main track in the cut, and the unloading track on the edge of the fill, so as to avoid the necessity and expense of a trestle for making the new fill. In excavating a single-track cut with a steam shovel, especially in rock, such equipment may enable the cut to be taken out to grade without removing material outside of the established cross-section lines.

These cars (4 to 6 yd.) are of advantage in making fills from trestles on small work, as larger cars require more substantial trestles, which may not be economical for temporary service. To prevent a heavy or sticky load from upsetting the car when the body is dumped, anchors are sometimes used, which the dumpers hook under the rail and over the frame of the car. The cars are of advantage also on new construction where the condition of roadbed and track precludes the use of heavier equipment. Further, with the small car there is a saving in cost of track material and in the work of laying, shifting and maintaining track.

Large High-Body Tilting Cars

Cars of this kind are not often desirable for railway forces, as they constitute a special class of equipment, which is not permanently required and which cannot be utilized for other purposes. One railway, however, uses 4-yd. narrow-gage cars on widening and double-tracking work, where the haul is short, as they can be operated without interfering with main-line traffic. Where the haul is long, this railway prefers 30-yd. cars of the same general type, operating on the main tracks.

In general design these cars are similar to the cars of the previous class, but they are mounted on eight wheels, with standard-gage trucks, and have a capacity of 12 to 30 yd. They are used both by railways and contractors. For operation as work trains on main lines they must have standard coupler and airbrake equipment to comply with the Federal laws. They are suitable, of course, only on work involving considerable yardage of excavation and long haul, with powerful locomotives available.

On some of these cars the dumping and righting of the bodies are accomplished by compressed-air cylinders, the piston rods being either horizontal with chain connections or vertical and connected directly to the body. The air operation conduces to speed, economy and safety in the work, especially on trestles. The angle of dump is usually 45° or over. In some designs the body is held by side chains to prevent accidental tilting during transportation. These chains must be released to permit operation; then they are coupled up when the empty car is righted. In other designs the body is secured by latches that are released by the pneumatic operating mechanism and are engaged and locked automatically when the car body returns to its normal position.

The side doors are separate from the body and are so arranged that as the body tilts downward the door on that side swings upward. This protects the door from damage as the load shifts and gives a clear passage for a load that is piled high or contains stumps and boulders. The cars are of special advantage for handling rock excavation and heavy material. With a wet and sticky or frozen load there is sometimes liability of the car going over when the body is dumped.

A 16-yd. air-operated car of this type, as used by the Pennsylvania Lines, is illustrated in Fig. 5. The upper view shows the door arrangement, and the lower view shows the operating mechanism. This car is built by the Kilbourne & Jacobs Manufacturing Co., of Columbus, Ohio, and is of the type in which the air cylinder is vertical and moves the body without the aid of chains. When in normal position for transportation the body is secured by latches, so that no side chains are used, such as are seen on the cars in Figs. 3 and 4.

For heavy construction and railway work especially there is an increasing tendency to choose these large cars. They are specially desirable when the haul is more than 4 or 5 mi., in order to obtain unit train loads as large as possible. Some contractors consider 1,000,000 yd. about the minimum amount of material for the selection of such cars. Their use applies more particularly where the cars are to be operated on main tracks (whether by the railway or the contractor). It applies also where they are operated exclusively on construction tracks, but of course these tracks (and their trestles) must be built of a more substantial character and must be given more attention for maintenance than is required by smaller and lighter cars.

There is difference of opinion as to the relative advantages of the different sizes of cars of this class, which range from 12 to 30 yd. in capacity. A train of six side-dump cars of 30-yd. capacity and all-steel construction is shown in Fig. 4, with three of the cars dumped. These are built by the Western Wheeled Scraper Co., of Aurora, Ill. The cars are shown placing material for widening a fill, and at the rear of the train is a spreader car to level the material to the subgrade elevation.

The 12-yd. car is considered very satisfactory for general railway or construction work. It can be used on short or long hauls and on running lines or construction tracks. Some engineers and contractors deem 12- and 18-yd. cars best for making banks where it is possible to raise track as the fill proceeds instead of dumping from a trestle. They are suitable also for widening banks after trestles have been filled to grade, provided that the material of the new bank is of sufficiently good quality to enable the track to be maintained economically in condition to carry these cars. Others favor a 16-yd. car of all-steel construction.

Granting that both railways and contractors advocate the use of the larger equipment on account of its economies, they should recognize the necessity of maintaining their construction tracks in such condition that these economies may be realized. The important point of keeping these tracks in safe and passable condition is apt to be overlooked and neglected by the men in charge. But a few derailments of these large and heavily loaded cars, with consequent interruption to the work, may so lower the performance and increase the expense as to wipe out the expected saving in time and cost.

A point frequently urged in favor of the 12-yd. car is its relatively high capacity and low weight. One engineer in particular notes that on new fills in wet material the engines caused considerable trouble, while the 12-yd. cars did not affect the track. If cars of 25- to 30-yd. capacity had been used, they would have caused as much trouble as the engines; and probably it would not have been practicable to operate them until the bank had dried out. Another engineer considers that cars of greater capacity than 12 yd. are desirable for making high fills where the load easily falls clear of the track, as the cost of train service, dumping, etc., is less with the larger cars. As pointed out elsewhere, the character of the work has a strong influence upon the selection of equipment, but in many cases there can be no selection on merits alone, as the work must be done with equipment already owned.

In filling trestles the shock of dumping these very large cars must be considered, as it tends to rack the trestle and throw it out of line. This is not of importance with temporary trestles, provided they are of strength sufficient to stand the rough usage—which is not always the case and would require a materially increased cost for timber. It must be taken into account especially in filling trestles on running tracks, where the structures are perhaps old and more or less weakened. One railway having both 16-yd. and 30-yd. cars has not used the larger ones for filling from temporary trestles or old main-track trestles, as the timber is liable to damage. It has used the 16-yd. cars on temporary trestles, but considers the 12-yd. more economical, as the style of trestle to handle the 16-yd. equipment was unduly expensive.

In this case the engineer considered that the 12-yd. hand-operated dump-cars were best for filling trestles and that the 16-yd. air-dump cars were most satisfactory for general purposes. The 30-yd. air-dump car, in connection with an air-operated spreader car, is the more satisfactory in widening banks for second track where the traffic is not too heavy or where the traffic is dense and the haul is long. With this equipment the greater part of the bank can be constructed from the main track with little delay to traffic. When the haul is short, however, this engineer

prefers narrow-gage equipment for second-track work, as it can be handled independently of main-line traffic.

The 30-yd. air-dump cars are used to advantage also in removing slides on new construction, where the track has been raised on ballast and slides have come in after the line was practically ready for operation. In such cases these cars require only a small force and are economical, but they are not satisfactory for use on temporary roadbed (unballasted), as they cause excessive cost of track maintenance.

On railways that do a large amount of construction or improvement work by their own forces cars of this class are considered a good investment. For such work as ditching, widening and clearing cuts, etc., there is an increasing tendency to use short quick-moving trains with two to four dump-cars rather than the usual long and slow train of flat-cars (*Engineering News*, Mar. 16, 1916). In this way the work may be done enconomically and with a minimum interference with traffic.

A train having a ditching machine or loader mounted between two 20-yd. dump-cars, or two loaders and four dump-cars, can be loaded quickly and make rapid movements to and from the dumping point or the nearest siding. Some roads prefer the large all-steel dump-cars with rigid locks instead of side chains, as they are more stable at ordinary speeds and will stand the rough usage better. Such cars are rated at 100,000 lb. capacity and will carry 24 to 30 yd. each.

Large high-pitched dump-cars are not suitable for ballasting, as they would throw the material too far from the track and deposit it in quantities too large for proper distribution. Nor can they be diverted to freight service when not required in work-train service. In handling material from steam shovels with dump-cars and flat-cars the Kansas City Terminal Ry. has found the cost per cubic yard to be about 11.3c. with 12-yd. dump-cars and 28.5c. with flat-cars. The greatest difference was in the items of car repairs and engine service.

Large dump-cars of other types and the use of flat-cars and unloader plows will be dealt with in a succeeding article.

Portable Steel Buildings on Construction Work

Portable buildings composed of steel units are being used for engineers' and contractors' offices on construction work and for similar purposes. A contractor's building of this type is shown in Fig. 1. The structure consists of pressed-steel panels, trusses and other parts put together without the use of bolts or rivets. The fastening used is a T-shaped lug, whose stem passes through holes in the units; the stem is slotted to receive a locking wedge. Hand hammers are the only tools required in erecting and dismantling the building.

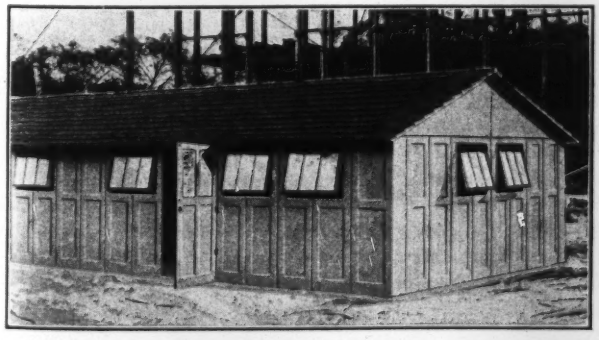


FIG. 1. CONTRACTOR'S OFFICE BUILT OF PORTABLE STEEL UNITS

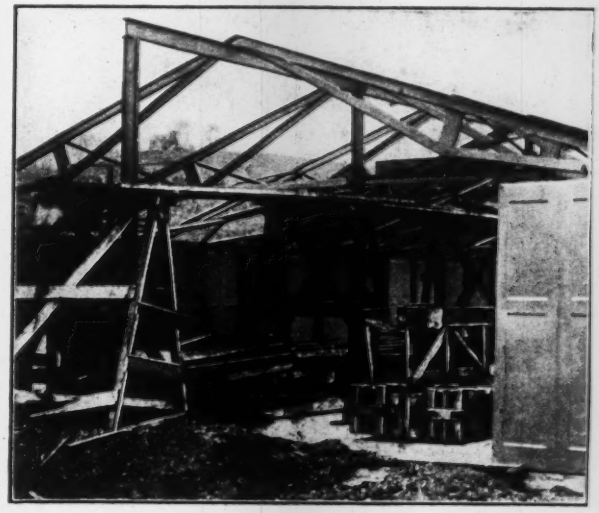


FIG. 2. ERECTING A PORTABLE STEEL BUILDING

The panels are of No. 18 steel plate flanged on all sides, the flanges being slotted for the fastenings. They are uniformly 7 ft. 10 in. high and either 2 ft. or 4 ft. wide. For the corners angle-shaped panels are used to insure a weatherproof structure. The vertical flanges fit the steel mullions placed between the panels, and weather stops are provided in all joints. The panels may be solid or glazed and may have ventilating openings with pivoted sash. End-gable panels and doors with hinges, latches and locks form part of the equipment.

The roof trusses are of different designs for spans of 6 to 28 ft. They have electrically welded connections so that they form single units. Longitudinal bracing is provided. In some designs the trusses are carried only at each end by the mullions, while in others there are central columns carrying a ridge beam. Fig. 2 shows the latter arrangement. The roof sheathing is of longitudinal steel plates, secured to the trusses by clips. They have flanged joints, which are made waterproof by special strips interlocking over the interior flanges of the plates. The buildings may be placed on wood sills or concrete foundation.

These portable steel structures have been used also as railway-yard and switchmen's shanties, section houses, bunkhouses, garages, hospitals, voting booths, roadside waiting rooms on electric railways, camp buildings, temporary offices and various other purposes. They are manufactured by the Trussed Concrete Steel Co., of Youngstown, Ohio.

A Steamship Company Operating a Round-the-World line of vessels has just begun operation through the Panama Canal. The company is the New Zealand Shipping Co., which has previously routed its vessels around the Cape of Good Hope on the outward voyage to Great Britain and around Cape Horn on the homeward trip. On its outward voyage the vessel sails from Great Britain around the Cape of Good Hope and traverses a distance of 12,916 mi. by way of Teneriffe, Capetown, Hobart and Auckland. From Wellington the homeward route henceforth will be by way of the Panama Canal and Norfolk where coal is taken on for the transatlantic trip and thence to Plymouth.

Successful Sewage Disposal by Broad Irrigation

By Terrell Bartlett*

SYNOPSIS—Some 1,600 acres of privately owned land are irrigated through the agency of an intermediary company, to which the city delivers the sewage. A natural lake, enlarged for the purpose, is used to store the sewage when not needed for irrigation.

No expense for disposing of its sewage has been incurred for many years by San Antonio, Tex., with a population approaching 120,000. The entire flow of sewage, now averaging about 13,500,000 gal. daily, is delivered to an irrigation company, which utilizes the water commercially and under its contract agrees to effect disposal and protect the city from all damage claims.

In the early nineties San Antonio constructed extensive sewers and endeavored to solve the problem of disposal by purchasing a tract of 800 acres five miles from the center of the city. This tract was operated under broad irrigation, at a loss, for two or three years, and proved a complete failure owing to the impossibility of utilizing the water for farming during the winter months. Through the winter and at times of wet weather, the water wasted from the farm to the San Antonio River, in which the flow was at times as low as 10 or 12 cu.ft. per sec.

Irrigation Ditches Polluted

Five miles below the city two irrigation ditches, one on either bank of the river, with water rights going back to Spanish days, take out the entire dry-weather flow for irrigating some 1,000 acres of thickly settled and highly cultivated truck farms. The river and these ditches soon become badly polluted. Suits were filed against the city by riparian owners, and by property holders adjacent to the farm, to the extent of more than $750,000.

These suits were settled by agreement on the part of the city to carry the sewage into the watershed of the Medina River, to Mitchell's Lake, a broad shallow basin, whose owners organized the San Antonio Irrigation Co., which agreed, on consideration of the delivery of the sewage by the city, to protect the city from damages caused thereby. The right-of-way for the 5½-mi. open ditch, together with immunity from damage claims along the line, was secured by granting to the various land owners water rights for stated lands aggregating about 100 acres.

The company secured a lease on favorably located lands adjacent to the lower end of the ditch and lake and the city is secured in its contract with the company by a lien on this leasehold.

In addition to the 100 acres irrigated by various land owners along the ditch, a land company and private owners irrigate about 800 acres above the lake by gravity direct from the ditch, 400 acres by gravity below the lake, and by a 10-ft. lift from the lake, 300 acres more, making a total net irrigated acreage of 1,600 acres.

*Of Bartlett & Ranney, Inc., Consulting Engineers, San Antonio, Tex.

During the nonirrigating seasons the flow of sewage is stored in the lake. Until recent years this sewage was diluted by the storm runoff from some 7,000 acres which drains into the lake, but this fresh-water inflow is now considerably curtailed by two fresh-water ponds which impound a supply of water for the domestic use of the farm tenants and for fishing as well as for irrigating a few acres.

Kinds of Crops Raised

The crops raised have consisted principally of foodstuffs, sorghum, Johnson grass and some alfalfa, with a small amount of irrigated cotton at times. The raising of vegetables has never been permitted by the company although considerable public excitement was developed in San Antonio several years ago by the discovery that some land owners along the ditch and not under control of the company were raising garden truck for the local market.

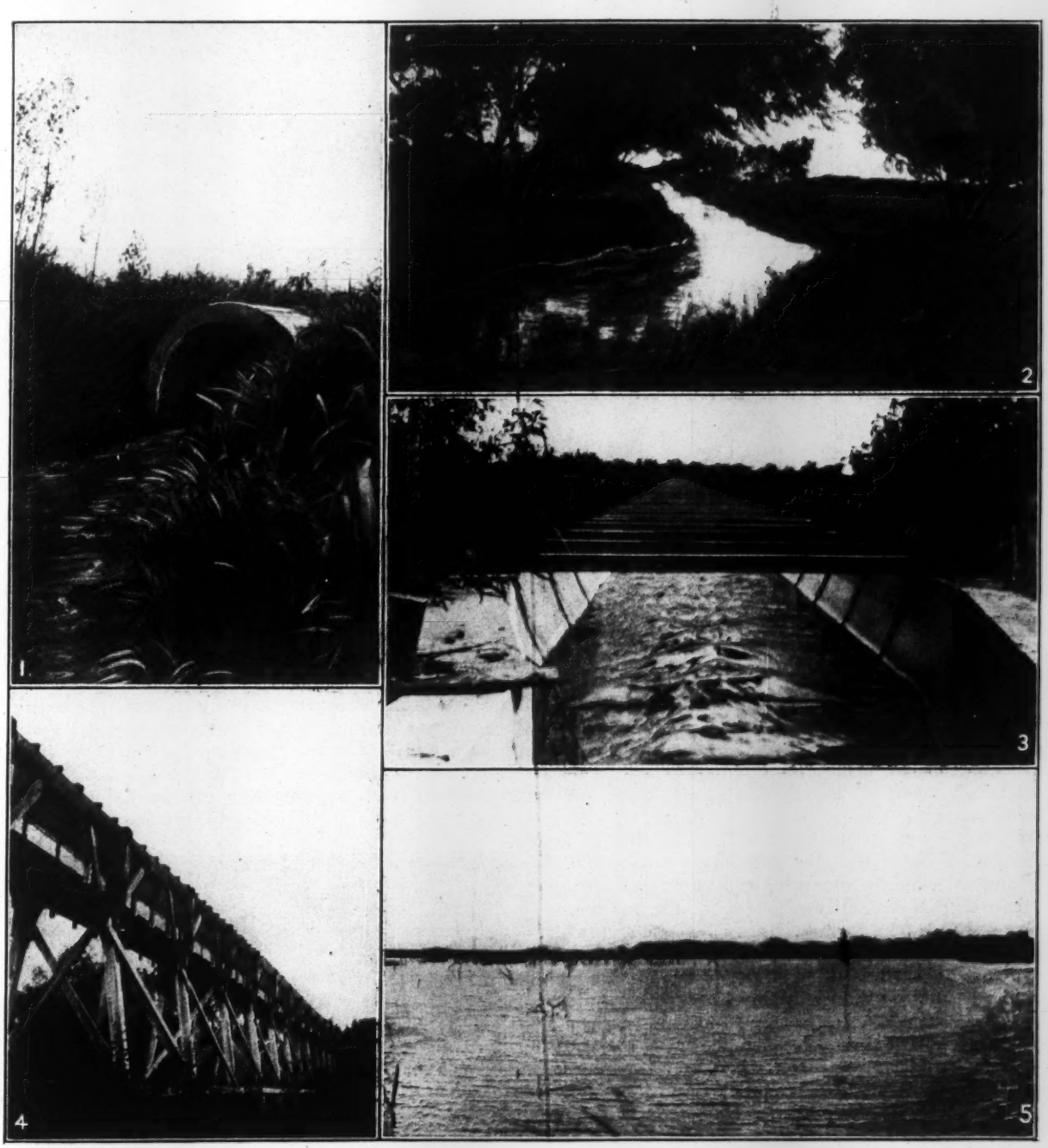
The lands have been farmed on a cash rental basis, principally with Mexican tenants of the better class, to the number of approximately 100 families. With a total population of some 500 people on the farm there has been very little sickness and only five or six mild cases of typhoid in as many years.

The company has recently inaugurated a policy of converting the farms into Johnson-grass pastures and stocking them with several hundred head of cattle. During the growing season one acre will carry two head of cattle. The forage crop will thus be marketed on the farm direct without the expense of cutting, baling and shipping and the number of hands reduced to 40 or 50. A further advantage will be the possibility of continuing irrigation through the winter season.

Amount and Disposition of Sewage

The present annual quantity of sewage received from the city's trunk outlet is roughly estimated at 15,000 acre-ft. Of this some 8,000 acre-ft. are applied to the lands by broad irrigation at an estimated average daily rate of 10,000 gal. per acre during the season. The remainder is impounded in the lake, together with from 400 to 800 acre-ft. of storm water. From a small marshy flat the lake has been extended by successive increases in the height of the dam until it now covers some 900 acres to an average depth of from 8 to 10 ft. Evaporation and seepage losses from the lake and ditches probably average 6,000 acre-ft. annually. In wet seasons heretofore, when there was no winter irrigation and when the storm water runoff was large and the evaporation small, it has been necessary to waste from 500 to 1,500 acre-ft. into the Medina River which forms the southern boundary of the lands. This has been done at times of freshets when the dilution was very considerable, and has caused no serious complaints.

The owners expect to construct a reservoir in the river bank above natural gravel beds through which some water from the lake may be filtered and wasted into the river.



UTILIZING SEWAGE FOR BROAD IRRIGATION, SAN ANTONIO, TEX.

1—Outlet of 72-in. sewer. 2—Sewer ditch 4 mi. below city limits. 3—Hess metallic flume on sewer ditch. 4—Carrying Hess metallic flume on old bents that originally carried cypress box flume. 5—Looking over 900-acre lake for storing sewage flow

The bed of the Medina lies some 60 ft. lower than the general level of the irrigated lands and there is a small seepage flow into it which has caused no nuisance.

The results of the disposal from the standpoint of avoidance of nuisance are extremely successful. Along the line of the ditch there is in warm weather some odor but this is never noticeable at greater distances than 100 yd. to leeward. The broad, shallow lake with partial dilution and abundant opportunity for sedimentation and oxidation effects a high degree of purification and there is no odor from it except a slight marshy smell, detected especially in warm weather. The water of the lake, while inoffensive, is distinguishably green with algæ.

From a commercial standpoint the Irrigation Company appears to be successful, judging by continued improvements to the irrigation and farm structures and its solvency throughout the past 15 years.

Government Forest Reservations in the Appalachian and White Mountain regions now aggregate 1,396.367 acres, including in this about 67,000 acres in 59 tracts whose purchase has just been approved by the National Forest Reservation Commission.

Large Mill-Refuse Burner Built of Concrete and Brick

By N. J. Blagen*

A concrete lumber-waste burner 63 ft. 8 in. in diameter and 104 ft. high, which has proved to be of unusual interest to engineers and mill owners, has just been completed by the Gray's Harbor Lumber Co., at Hoquiam, Wash. The structure was designed by the writer and

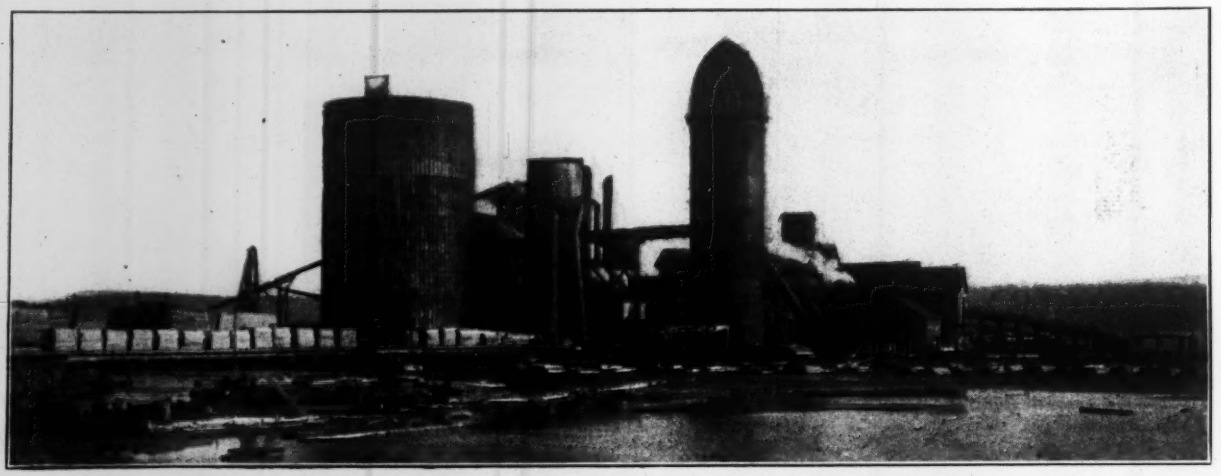


FIG. 1. CONCRETE WASTE BURNER; GRAY'S HARBOR LUMBER CO., HOQUIAM, WASH.

son, Frank N. Blagen, mechanical engineer of the lumber company. We selected concrete as the material for the shell in place of steel because of our experience with the two materials under the conditions that had to be considered. Our old burner had a steel shell, and it corroded rapidly because of exposure to salt air. Moreover, the concrete shell could be put up here at half the cost of steel. We have made many successful tests of concrete subjected to much greater heat than a waste-burner shell is ordinarily subjected to; for instance, we have had in service for four years a concrete arch under the bridge-wall of a pair of boilers. It is not subjected to direct fire, but it is so hot on the outside that the hand cannot be held on it. It is still perfect. Our old steel shell has never been hot enough to melt the asphalt on the outside except at the top, where the flames could reach it. We have, however, as a special extra precaution, provided for the complete ventilation of the shell, as will be seen from the design (Fig. 3). We think the burner shell will never get warmer than the sun will make it in summer.

At first we planned building the shell with its outer wall of concrete 8 in. thick for the entire height; we were to have a 4-in. air space and then a second wall 8 in. thick and 40 ft. high, topped by brick going up the rest of the distance. Inside this was a second 4-in. air space and a third wall, this last of brick and only 12 ft. high. Before starting work, however, we changed to a single main wall outside, of 10 in. of concrete, with an inner 8-in. brick wall separated from the first by a 4-in. air space but having for stability, every 2 ft. up and across, a brick projecting out against the concrete of the wall. An 8-in. vent was left about every 4 ft. around the top and bottom, allowing a current of air to circulate up through.

The inner wall was nothing more than good common brick laid in common clay. The clay was ground, dissolved and boiled, and mixed with a very little cement and salt. It was applied thin enough so that the masons spread it with a dipper instead of a trowel; that is, they took a large dipperful and spread it over the top of one course before laying any of the next course. When the next bricks were put down in this thin clay, a joint space of not more than $\frac{1}{16}$ in. was left—just enough to form a bed. When the bricks were all laid, the entire inside was washed down with thin clay, containing no cement but with a little more salt, so that the inside would take a glaze that would protect the brick.

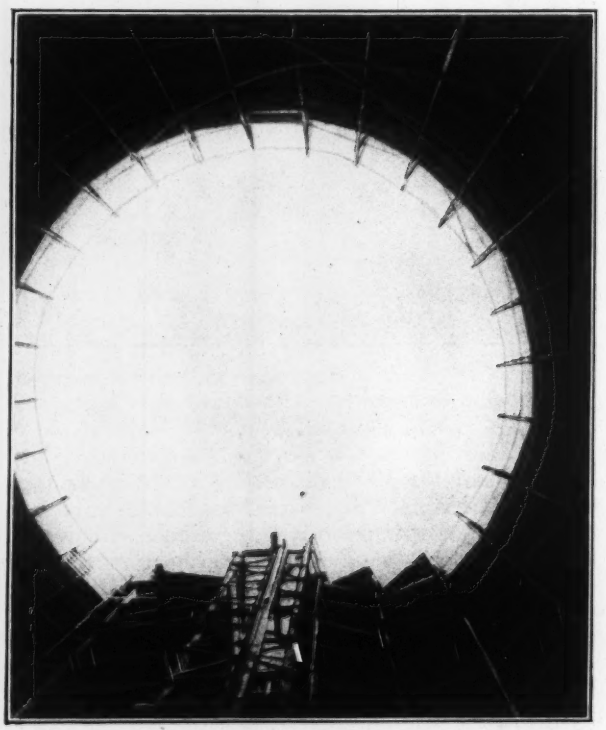


FIG. 2. LOOKING UP INSIDE THE HOQUIAM BURNER

*President and Manager, Gray's Harbor Lumber Co., Hoquiam, Wash.

Laying brick in this way is not new. It has been done out here for many years. Our old steel burner has a common brick lining which for seven years has withstood the highest heat any burner of this sort can be subjected to.

The new burner was built on soft-mud tide flats, and it was necessary to drive piles to a depth of 40 ft. to get a firm foundation. They were driven to support 20 tons per pile, though they will not be subjected to a load greater than 10 tons. Very large piles were selected, averaging fully 20 in. in diameter at the large end. As they are submerged practically every day, there is no danger of decay within the lifetime of the burner.

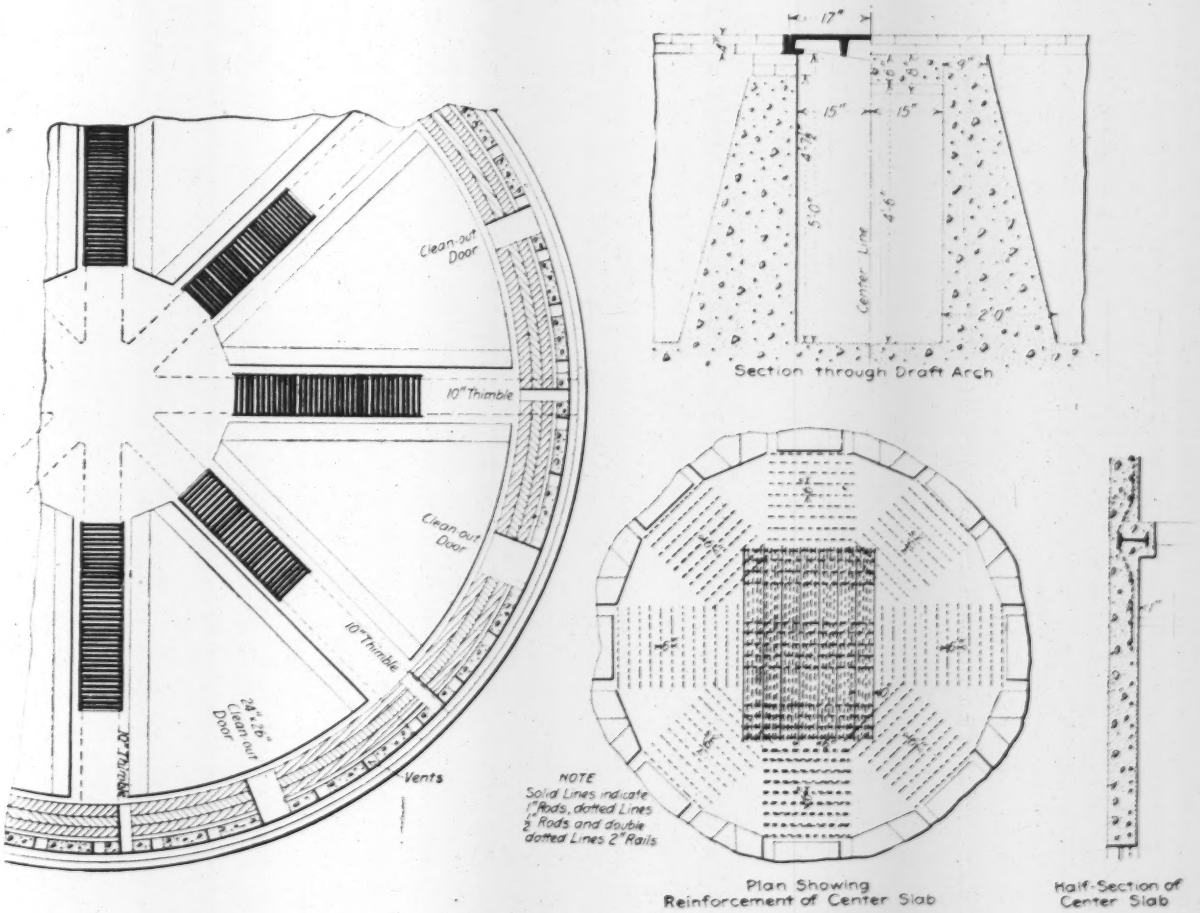


FIG. 3. DETAILS OF DESIGN, WASTE BURNER OF GRAY'S HARBOR LUMBER CO.

The work was all done by day labor and therefore no specifications were written. We gave our superintendent instructions from time to time and also closely watched progress. This was more satisfactory in a small out-of-the-way place like this than it might have been in a large city where we could have let the job to a first-class contractor who we could have been sure would have done good work and saved us the trouble of looking after the job so closely.

The concrete was an ordinary 1:2:4 mix, using local sand and stone. Mixing was done by a drum mixer. The forms were built out of 8-ft. studding, and the scaffold was carried up on the inside in 8-ft. lifts. Material was lifted on a platform elevator holding three wheelbarrows. We could pour an 8-ft. lift in one day, and on the next day the men built the scaffolding and forms for another 8-ft. lift. This gave an average progress of 4 ft. per day. We used 8-ft. lifts because we had a lot of 2x6's in that length that had proved a slow seller. Each scaffold was covered with plank as we went up, and we left them there for the brick masons to work on. This would not have been practical for the ordinary contractor, but it was for us with our big stock of low-value short material of the right length to reach from bracket to bracket.

As we laid the brick, we provided small trestles 2 ft. high to be placed next to the wall for the masons to stand on in laying the upper 2 ft. of each lift. This worked out very conveniently and economically. There was ample headroom between each scaffold for the necessary cross-brackets and for braces running under the bracket around the circle. The forms were built by the concrete gang with a few of our millwrights. The concreters not busy on the alternate (form-making) days were set to wheeling in the earth fill on top of the foundation slab. Thus we did a first-class job at a very reasonable cost. The concrete materials cost us about $2.80 per cu.yd.; the labor in concreting the main walls was approximately $1 per yd. The work on the foundations cost about 50c. per yd. of concrete. The entire cost of the structure lined was $17,000, including the top screen, or spark arrester, but not including the conveyor leading to it, which will be about $3,500.

Automatic Skip Handles Hot Ore

By H. V. Schiefer*

The handling of hot nodulized ore from kilns to storage bins by railroad cars at the plant of the Benson Mines Co., Benson Mines, N. Y., is accomplished by the use of a double automatic skip hoist. The red-hot nodulized ore is discharged from two revolving kilns into a storage hopper with two gates in the bottom. In drawing the red-hot material from this hopper a stream of water is sprayed on it, which causes the pit under the hopper to be full of steam and hot water. Any sort of conveyor or elevator was of course out of the question, so a skip hoist was built that is entirely automatic, requiring no inspection whatever in the pit.

The material handled being of an extremely abrasive character, a gate of unusual and rugged design was adopted. These two gates are furnished with an outside shell of cast steel, with ribs on the inside. Between these ribs is provided a special hard-iron lining. Between the inside lining and the outside cast-steel frame is an air space to assist in the cooling of the gate. For stopping the flow of the material, there is a semicircular cutoff gate on the inside of the stationary gate, operated by a bell crank and connection to the skip-hoist bucket. The construction of this gate is shown in Fig. 4.

There are two skip buckets, in balance, which are $2\frac{1}{2}$ ft. square and 3 ft. long, having a normal capacity of $1\frac{1}{2}$ tons of material weighing 160 lb. per cu.ft. The bottom of the buckets is constructed of $\frac{1}{4}$-in. plate, and on three sides is provided an extra $\frac{1}{4}$-in. plate-steel lining fastened on with countersunk-head bolts so that they may be removed when the lining is worn out. The bucket is mounted on two axles of $2\frac{3}{16}$-in. diameter, with the outer ends fitted with flanged rollers, which are keyed to the axles. The axles in turn rotate in a bearing on the under side of the skip bucket. The rollers are 14 in. in diameter. The two rear rollers have special treads, so as to dump the bucket at the discharge end of the skip hoist. The buckets are provided with heavy forged-steel bale bars fastened to the lower end of the bucket.

The skip hoist is entirely automatic. When one skip bucket is in the lower position, it rests on a counter-weighted lever. When sufficient weight of material is deposited in the bucket, the load raises the counter-weighted lever. This lever, in rising, pulls a rope operating an electric switch, which admits current to the hoist

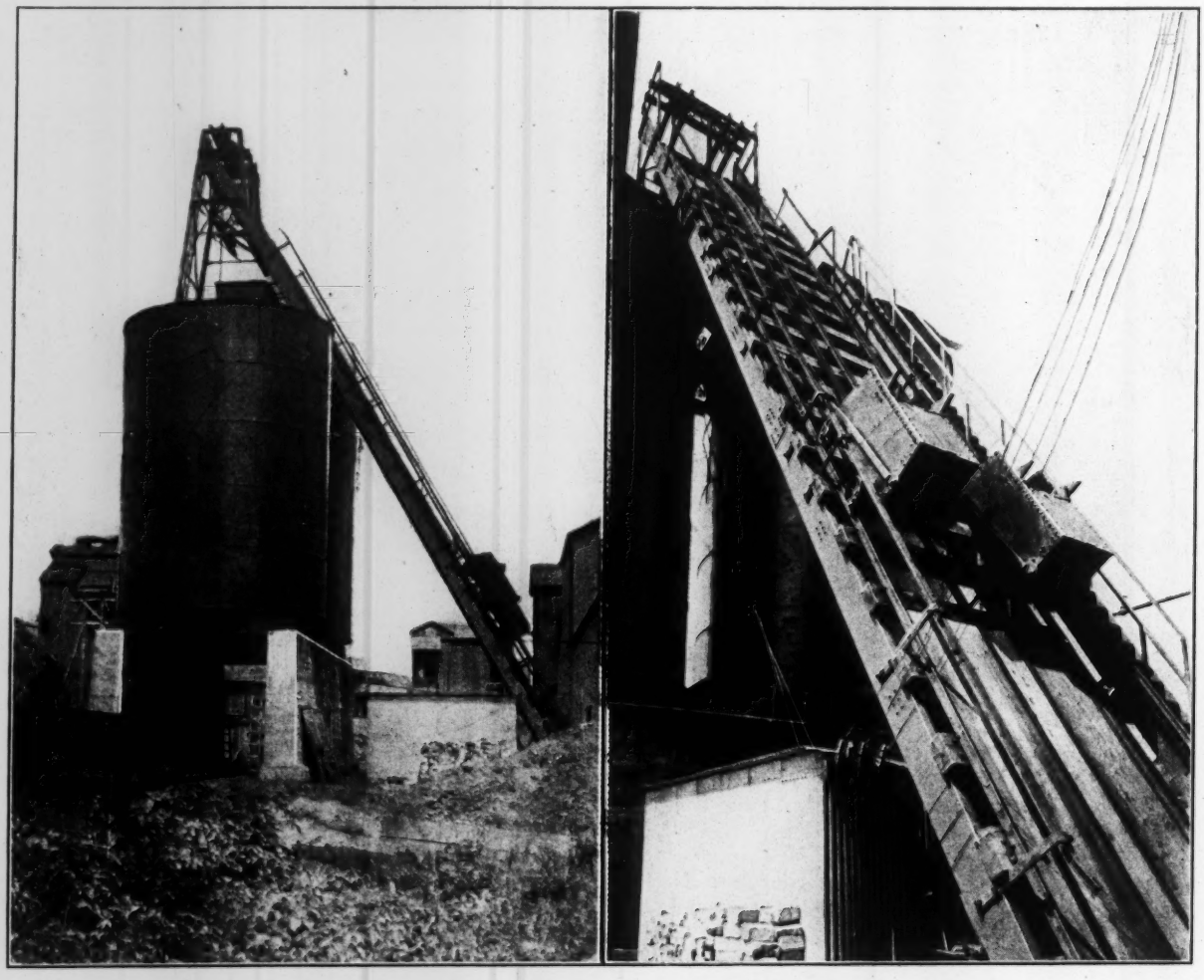


FIG. 1. AUTOMATIC SKIP HOIST FOR HOT ORE AT BENSON MINES, N. Y.

*Engineer, C. O. Bartlett & Snow Co., Cleveland, Ohio.

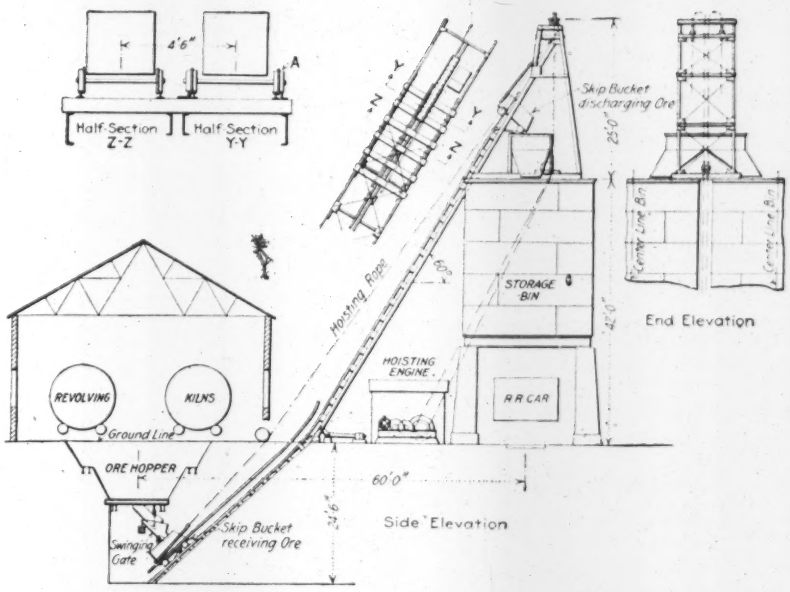


FIG. 2. DETAILS OF AUTOMATIC SKIP HOIST AT BENSON MINES

motor. The bucket then starts upward slowly, allowing the counterweighted gate to close, stopping the flow of material. After a short period of time, by means of an automatic control system the motor is accelerated and the bucket travels at full speed until it is within a few feet of the top or dumping position, where it slows down and comes to a stop, at the same time discharging its load. At the time one bucket is going up, the other is coming down, and at the same speed, since both buckets are attached to the same hoisting drums. As the descending bucket reaches the bottom, it pulls the gate open by means of a dog engaging a lug on the gate and comes to rest on the counterweighted lever, thus completing a cycle of operation. Fig. 4 shows the detailed construction of the mechanical part of the automatic mechanism at the lower end of the skip hoist. As the skip bucket descends, the lug on the bucket *E* engages the roller *G* on the swinging part of the gate *H*; and as the bucket moves down, it pulls the gate open, allowing ore to run into the bucket. The bucket is brought to rest by means of another lug *D* on the bottom of the bucket striking the small carriage *C*, which is mounted on wheels in a guide. This carriage *C* is connected by means of a lever and bell crank to a counterweighted lever on which is mounted the counterweight *A*, which controls the amount of material to be loaded into the bucket. When the bucket receives enough material to raise this counterweight, the electric switch *B* is operated by means of a rod connection, which admits current to the hoisting-engine motor, and the bucket starts upward.

At the top of the runway two sets of rails are provided, one pair for the front wheels of the skip bucket and the other pair, of wider gage, for engaging a special tread on the rear wheels. These wheels are shown at *A*, Fig. 2. As the skip bucket reaches the top, the front wheels run on the rails *A*, Fig. 3, while the rear wheels run on the rails *B*, thus giving bucket its dumping position. As the bucket reaches the position *F*, it strikes a lever *D*, which operates an electric switch *E*, thereby cutting off current from the motor and allowing the solenoid brake on the motor to set, holding the bucket in the dumping position. A bumping block is provided at *C* to prevent over-travel of the bucket.

The ropes used are steel, 5/8 in. in diameter, composed of six strands of 19 wires each; they run over cast-iron sheaves of 24-in. diameter. The hoist consists of a heavy structural-steel base upon which is mounted a 24-in. winding drum which is direct-connected to a 15-hp. 440-volt three-phase 60-cycle induction motor by means of a train of cut spur gears. An electric solenoid brake is mounted on the armature shaft.

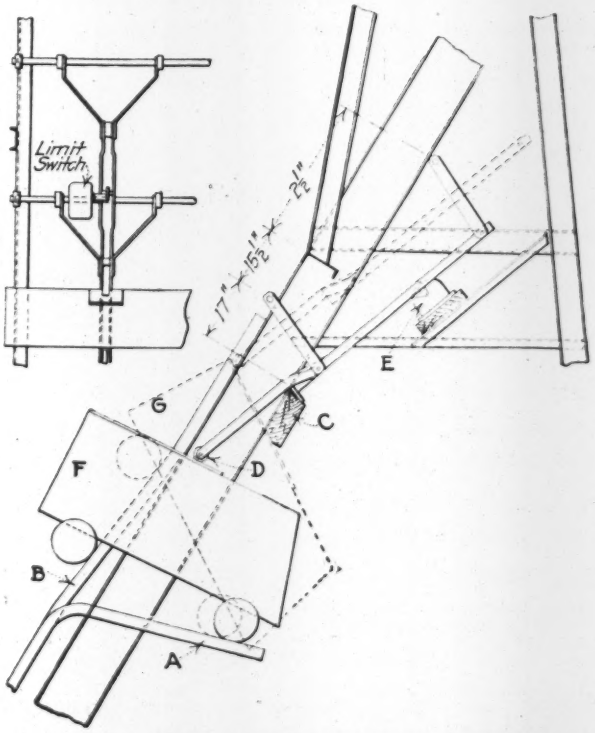


FIG. 3. DUMPING CONTROL AND LIMIT SWITCH

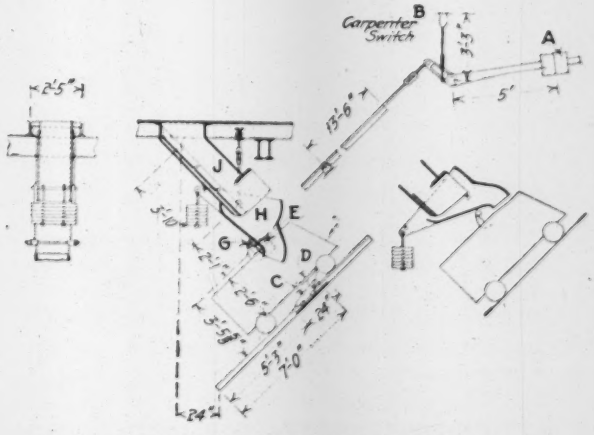


FIG. 4. ORE GATE AND CONTROL

The automatic electric control consists of a plain slate panel, supported on a steel frame on which is mounted a solenoid-operated primary reversing switch, also two solenoid-operated accelerating switches with their current relay. It is interesting to note that the primary reversing switch opens but two of three phases, this being all that is necessary to handle in order to reverse the motor. The third phase remains permanently connected to the line. The accelerating switches automatically cut resistance out of the rotor circuit under control of current relays. The solenoid switches are so designed as to cut one step of resistance out of the three phases of the rotor circuit simultaneously, thereby maintaining a proper electrical balance at all times. There is also provided an emergency switch so that the skip hoist can be operated by hand if so desired.

The skip hoist was designed and patented by the C. O. Bartlett & Snow Co., Cleveland, Ohio.

Reinforced-Concrete Pipe Used for Railway Culverts

SYNOPSIS—Many railways are now using reinforced-concrete pipe for culverts, and some are making their own pipe. This article describes several different types adopted on Western roads.

Reinforced-concrete pipe is being used very extensively for railway culverts, many roads employing it on a large scale. It is of two different types, circular and slightly oval in section, and is made with either bell or sleeve joints, the latter giving a flush or even surface to the culvert. Of thirty-five railways using these culverts, twenty-six purchase the pipe, which is made usually to the manufacturers' specifications, though a few of the roads have it manufactured to their own specifications. Six railways make the pipe at their own plants, and three of them both manufacture and purchase the pipe. The railway plants have capacities of 40 to 250 lin.ft. per day.

The Great Northern Ry. purchases the pipe, but has it made to its own plans and specifications, though it is thought that the pipe might be cheaper if made by company forces. Both bell and sleeve joints are used, the latter being shown in Fig. 1. The pipe is slightly oval in section, and has a single course of reinforcing rings which are so bent as to lie near the inner surface at top and bottom and near the outer surface at the sides. At each end there is a wrapping of triangular-mesh wire netting; that at the socket end lies near the outer surface while that at the spigot end lies near the inner surface. To insure accuracy in placing the pipe with its longer axis vertical, the word "top" is stamped at top and bottom.

The nominal 60-in. pipe is 60 in. wide and 67 in. high, made in lengths of 6 ft., with a 4-in. socket and spigot, making an effective length of 5 ft. 4 in. It has 16 longitudinal deformed bars and 15 hoops. The latter have 15-in. laps, which are located at 45° from the vertical axis and are wrapped with wire. The pipe has 1.93 yd. of concrete and 307.6 lb. of steel; it weighs about 7,880 lb. For smaller sizes, a greater length is used, the 36-in. pipe (36x40 in.) being 8 ft. long over all. This weighs about 4,300 lb., with 1.06 yd. of concrete and 141.2 lb. of steel.

The concrete mix is 1 : 1½ : 4. The coarse aggregate may be stone passing a 1-in. and retained by a ¼-in. screen, or clean gravel that will pass a 1-in. screen. The forms are specified to be of metal or lined with metal, with all edges filleted, and the form is greased before each pipe is made. The concrete is to be mixed by machine when the amount of pipe is sufficient to warrant this, and is to be spaded or puddled against the faces of the mold as it is deposited. Special care is to be taken to prevent voids and to have the reinforcement thoroughly embedded and in its proper position. The reinforcement must be not more than 1 in. from the inner surface at top and bottom, and 1 in. from the outer surface at the sides.

The Michigan Central R.R. uses pipe of truly circular section (instead of the oval form noted above and used on several other roads). The circumferential reinforcement also consists of two concentric sets of circular rings and longitudinal bars, instead of the single set of rings and longitudinals arranged in oval form, as in the previous design. This latter arrangement, however, is permitted. The railway company purchases the pipe, but has it made to the company's specifications.

This pipe is shown in Fig. 1. The 6-ft. pipe is 7¼ in. thick, 5 ft. 4 in. long over all, with an effective length of 5 ft. All reinforcement is of ½-in. square deformed bars of openhearth medium steel. The rings are spaced 4 in. c. to c. in each row (with rows staggered), and have 9-in. laps wrapped with 24 turns of No. 16 wire. These

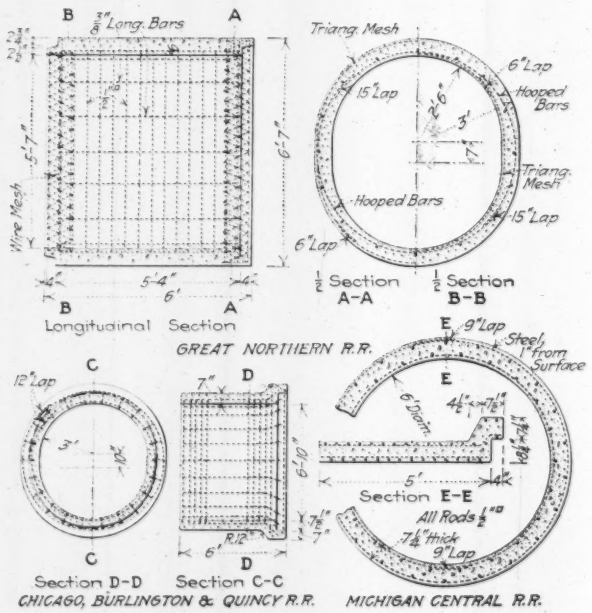


FIG. 1. THREE DESIGNS OF REINFORCED-CONCRETE PIPE FOR RAILWAY CULVERTS

laps or splices are at points 45° from the vertical and horizontal diameters. The longitudinal bars are spaced not less than 12 in. apart, and all intersections are secured with No. 16 wire drawn tight. The 3-ft. pipe is 4¼ in. thick, with ⅜-in. rods placed ¾ in. from the surfaces. This is made in lengths of 6 ft. 4 in., the effective length being 6 ft. The concrete is specified to be a 1:2:4 mix, using either gravel or crushed stone which will pass a 1-in. screen and be held on a ¼-in. screen.

The Chicago, Burlington & Quincy R.R. uses a patented pipe, but finds that it can make the pipe by its own forces cheaper than it can have it made by contract under the railway specifications. This road has two

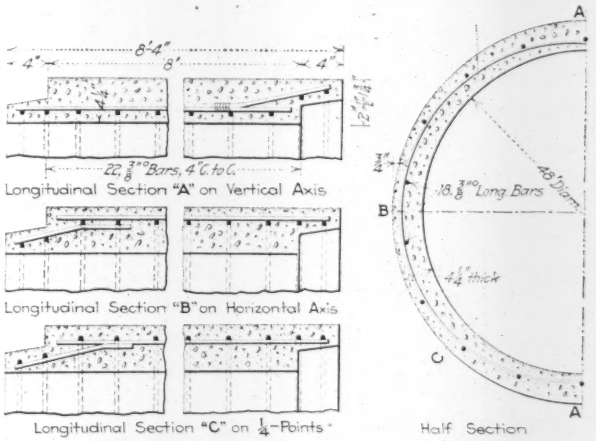


FIG. 2. REINFORCED-CONCRETE CULVERT PIPE: CHICAGO & NORTHWESTERN RY.

pipe-making plants. The pipe is of slightly oval section with bell joints, as shown in Fig. 1. The reinforcing rings are of round steel bars bent to lie near the inner surface of top and bottom and near the outer surface at the sides. The longitudinal bars are bent to extend into the bell-end.

The 6-ft. pipe is 6 ft. wide and 6 ft. 10 in. high, 7 in. thick, made in lengths of 6 ft., or 5 ft. 6 in. effective length. The rings are either of ½-in. square bars 3½ in. c. to c., or ⅝-in. round bars 4 in. c. to c., with a single 12-in. lap. The longitudinal bars are ½ in. square or round. Each length of pipe contains 3.5 cu.yd. of concrete and 523 lb. of steel. The 4-ft. pipe is 4 ft. by 4 ft. 4 in., in 8-ft. lengths, which have an effective length of 7 ft. 8 in.

The Chicago & Northwestern Ry. uses sleeve-joint concrete pipe which is of true circular section (like that of the Michigan Central R.R.), but in which the reinforcement consists of a single set of oval rings and a single row of longitudinals as in the other pipes mentioned. In pipe from 18 to 30 in. in diameter the circumferential reinforcement consists of a sheet of triangular-mesh wire netting, but in 36- to 60-in. pipe it is of steel rings.

The sizes of reinforced-concrete culvert pipe range from 12 in. to 7 ft. in diameter. Some roads use a wide range including both these sizes; others use a smaller range, such as from 18 to 48 in., or 24 to 72 in. As to the cost, roads which make their pipe consider that the cost is less than if purchased; some roads which purchase pipe consider that they could make it at lower cost provided it was made in large quantities. The approximate range of quoted cost for pipe purchased and manufactured by the railways is shown in the accompanying table.

The minimum time for curing ranges from 40 to 60 days, and some roads require that all pipe laid must be

REINFORCED-CONCRETE CULVERT PIPE

Size, In.	Cost per Lin.Ft. Purchased, Dollars	Cost per Lin.Ft. Made by Railway, Dollars	Thickness, In.	Length, Ft.	Wt. per Ft.-Lb.
24	0.95 to 2.50	0.66 to 1.78	2 to 4½	2 to 6	225 to 405
36	2.10 to 4.00	1.00 to 2.40	3 to 5	2 to 8	445 to 590
48	4.04 to 5.75	1.47 to 2.88	4 to 6	6 to 8	815 to 890
60	5.00 to 8.00	2.54	5 to 7½	6	1,200
72	10.00		7	6	1,700
84	15.00		7	6½	2,000

at least 90 days old. Failures and breakages seem to be so limited as to be insignificant; green pipe is an occasional cause of failure, and breakage occurs generally in handling. Practice seems to be about equally divided as to cementing the joints, and one road reports that cement is used only in the bottom of the joint. The minimum depth from the base of rail to top of pipe is 18 in. in one case, and from 2 to 6 ft. in other cases. Some roads limit this depth to a maximum of 20 ft., others have no limit, and one road uses these culverts in banks as high as 65 ft. The Rock Island lines have two classes of pipe, one for fills up to 20 ft. high and the other (of heavier construction) for greater heights.

The thickness and length of the pipe vary widely, especially in the smaller sizes, as shown by the table. The weight is also very variable, due to the thickness and steel reinforcement. Thus in 24-in. pipe there are weights of 225 lb. per ft. for 2-in., 260 to 405 lb. for 3-in., and 395 lb. for 4½-in.; 36-in. pipe varies from 445 lb. for 3-in. to 590 lb. for 4-in.; and 48-in. pipe varies from 815 lb. for 4¼-in. to 933 lb. for 5½-in. and 980 lb. for 5-in. pipe. In the large sizes the weight is about 1,200 lb. per ft. for 60-in., 1,700 lb. for 72-in. and 2,000 lb. for 84-in.

In distributing the pipes, they are generally rolled from the cars to the roadbed, except that the larger ones are slid off by means of tackle. The largest sizes are handled by a derrick. The pipes may be hauled into place on skids with the aid of tackle. In laying them under trestles which are to be filled, however, the Fort Dodge, Des Moines & Southern Ry. uses a derrick car which picks up the pipes from the roadbed, carries it out on the trestle and lowers it into position.

The large 84-in. pipes (84x89 in.) are used for cattle-passes on the Minneapolis, St. Paul & Sault Ste. Marie Ry., and for this purpose the bottom has a flat floor for a width of 2 ft. These pipes were made by the C. F. Massey Co., of Chicago, whose standard design of pipe is made in this oval form. Their pipe is in sizes from 12x16 in. to 72x78 in., weighing 82 to 1,546 lb. per lin.ft.

The information given in the foregoing as to the use of reinforced-concrete pipe for railway culverts has been obtained from several railways and from detailed statistics prepared by a committee of the American Railway Bridge and Building Association.

A Demand for Highway Engineers exists today, according to statistics compiled by the National Automobile Chamber of Commerce, whose headquarters are in New York City. It is claimed that nearly 1,600 engineers are now employed by the 24 state commissions, and in addition about 2,000 are employed as county and city engineers in 19 of the states; salaries of highway engineers range from $900 to $5,000 a year, the average being about $1,800.

Water-Works Service Pipes*

The committee began its investigations by requesting information in regard to the materials and methods used in service-pipe construction, the troubles experienced and other matters which appeared to the committee to be of interest in this connection.

At two meetings of the committee a number of superintendents who appeared to have had exceptional opportunities to obtain valuable experience along lines which it seemed important to investigate were invited to be present, and each of these men was in turn questioned in regard to the details of his practice and experience.

In considering the information contained in the replies received, it should be borne in mind that the returns [248] from New England included a large number of small places. The returns from outside of New England [56] are chiefly confined to larger places.

Materials Used for Service Pipes

The returns in regard to the material now used for new services may be summarized as follows: Wrought iron or steel, 13; galvanized iron, 145; lead, 48; lead lined, 13; cement lined, 37; galvanized and lead, 14; galvanized and cement lined, 4; galvanized, lead and cement lined, 2; galvanized and lead lined, 10; iron and cement lined, 2; cement lined and lead lined, 1; cement lined and lead, 2; lead and lead lined, 4; lead and wrought iron, 3; miscellaneous, 6; total, 304.

The use of plain wrought iron or steel is becoming rare, while nearly one-half of the places sending in reports now use galvanized wrought iron or steel exclusively; in 56% of the places galvanized iron is used either exclusively or in part. In 95 places lead or lead-lined pipes are used, and cement-lined pipes in 48 places. It is noticeable that the use of cement-lined pipe is largely confined to Massachusetts and New Hampshire, 46 of the 48 places using it being in these two states.

Of the new water-works systems—those constructed within the past 10 years—the following materials have been used for services: Galvanized, 24; plain wrought iron, 1; lead, 2; cement lined, 9.

The disfavor with which plain iron and steel are regarded is shown by the fact that 22 places have changed from these materials to some other, while only one place has reported as having taken up this material. Galvanized pipe, on the other hand, has lost only 17 while gaining 46. Lead and lead-lined pipes have gained 18 and 16 places respectively and lost 6 and 8. Changes to cement-lined pipes have occurred in 11 places, and changes from cement-lined pipes to some other material have occurred in 27 places.

A comparison of the number of places now using the different materials with the number of places where this material has been abandoned shows that 63% of those formerly using plain iron or steel pipes have changed to some other material. Eight per cent. have changed from galvanized iron, 19% from lead or lead lined and 42% from cement lined.

The changes from plain and galvanized pipes are almost entirely on account of rust. The changes from lead pipes are largely on account of the possibility of lead poisoning, although in some cases it has been on account of expense or because of the bursting of the pipes under pressure. Lead-lined pipe has been abandoned on account of lead poisoning and trouble from bursting and because of the difficulty in making joints which will not corrode. Of 20 places reporting the abandonment of cement-lined pipes, 8 were on account of trouble at the joints, 6 for convenience, 2 on account of expense, 1 on account of the difficulty in getting good work, 1 because of rust, 1 because the cement broke off, 1 because of outside rust.

A large proportion of the places where the works have been in operation for a sufficient time report trouble with service pipes no matter what the material used, except in the case of cement-lined pipes. With cement-lined pipes 54% of the places heard from report little or no trouble. With galvanized pipe 36% of the places report little or no trouble, and with lead pipe 10% so report. The trouble with iron and steel pipes, both plain and galvanized, appears to be through the entire length of the pipe. The trouble with lead pipes appears largely at the corporation cock. The trouble with cement-lined pipes is very largely corrosion of the outside of the pipe just inside the cellar walls, with some trouble at the lead gooseneck.

The main sources of trouble from corrosion are largely inside the pipes, due to the action of the water. In certain soils, however, there is a rapid corrosion of the pipes on the outside, and in case the inside is protected, as in the case of cement-lined pipes, this is the main source of trouble. Pipes laid in salt marsh or in cinder-fill are certain to be acted upon rapidly. Pipes in clay are much more subject to corrosion on the outside than those in sand or gravel. One of the common places where trouble occurs is at the corporation cock, or where a gooseneck is used at the junction of the gooseneck with the service pipe. Some of the troubles at the corporation cock are due to the tuberculation of the main pipe, which tends to cover the corporation cock. This can be overcome in a large measure by inserting the corporation cock well beyond the inside of the main.

Plain Wrought Iron and Steel

The committee believes that there are very few cases where the use of either wrought iron or steel pipes without some protective coating for services is justifiable. They are certain to become filled with rust, and the expense of cleaning or renewing them will much more than offset the extra first cost of construction. Covering the metal with some protective paint seems to increase its life but slightly.

The experience of water-works superintendents as indicated by the returns and as shown by previous discussions in the meetings of the association is decidedly unfavorable to steel pipe, and while, undoubtedly, many of those who argue in favor of wrought-iron pipe may be unfamiliar with anything else and believe in it because they were taught to believe in it, there is certainly a large number of reliable men who have had an extended experience with both materials who are firmly convinced that wrought iron is much superior to steel, and there must be some good reason for this belief.

The feeling against steel pipe appears to be chiefly confined to New England, for it is undoubtedly a fact that a majority of pipes used in other sections of the country are of steel, and it is apparent that no more

*Portions of preliminary Report of Committee on Service Pipes, submitted to the New England Water-Works Association, Sept. 14, 1916, by W. S. Johnson, H. W. Clark, George A. Stacey, William F. Sullivan and A. E. Martin. The full report will appear in the "Journal" of the Association.

trouble is experienced from the use of steel in these places than is experienced from the use of wrought iron in this vicinity.

Galvanized Pipe and Lead Pipe

The chief trouble with galvanized pipe is in the joints, where the water gets directly at the iron, and in the imperfect covering of the iron. As pipes are manufactured, there is a large quantity of scale left on the pipe, especially on the inside. When the scale becomes loose, as it invariably will, the metal of the pipes is exposed in spots directly to the action of the water and corrosion begins, which tends to loosen still further the scale, and soon the pipe is little better than an uncoated pipe. One of the steel companies has now perfected a method of removing scale from the pipes which would seem to be of enormous advantage both in decreasing the friction in the pipe and in making it possible to obtain a much more durable coating of zinc when galvanized.

Galvanized pipe appears to be the cheapest practical material for services where the class of street surfacing is not such as to make the renewal of the services a matter of great expense. Whether steel pipe is as durable when galvanized as is wrought iron, is a matter which is open to discussion. If the galvanizing is perfect, it would make little difference whether the metal under the zinc resisted corrosion more or less. With the process for removing scale above referred to, it would seem that a long step had been made toward getting a perfect galvanized pipe.

Lead is in many respects the most satisfactory material to use for service pipes. Its pliability and its comparative freedom from corrosive action make it almost ideal from a mechanical standpoint. The cost of lead pipe of sufficient thickness safely to withstand the pressure is more than the cost of many other materials used for services, but in a paved street the greater duration of life probably more than compensates for the extra cost, and in places where the streets are occupied by other pipes and conduits the ease of getting over and under these obstructions with a flexible pipe is a great advantage.

The most serious objection to the use of lead pipe for services is the possibility that the water may dissolve enough lead from the pipe to cause lead poisoning. It is certain that many cases of lead poisoning have been caused by the use of lead services. On the other hand, lead has always been used for services in most of the large places without any unfavorable effects.

It seems to be practically impossible to determine definitely in advance what the effect of any water on lead pipe will be, as the laboratory results fail in many cases to show the action which will occur in actual practice. Tests of service pipes in use for a considerable period are the only safe guides.

Lead-Lined and Cement-Lined Pipes

Lead-lined pipe as manufactured several years ago gave much trouble from the separation of the lead lining from the iron, leaving the metal exposed to the water. The pipe as manufactured today, however, appears to be durable and prevents the corrosion of the iron or steel very effectively. It would seem that the life of such pipe would be limited only by the corrosion of the outside of the pipe. The expense of the lead-lined pipe is much less than that of lead pipe.

Cement-lined pipes, if properly constructed, make ideal service pipes as far as the interior of the pipe is concerned. The cement is not acted upon by water, and the interior of the pipe will remain smooth for an indefinite time. There are many places where cement-lined pipes have been in use for many years without any trouble, and there are many others where they have given so much trouble that their use has been discontinued. The reason for the troubles which have been experienced are found to be generally the improper lining of the pipes or the use of fittings which did not prevent the water from getting to the metal.

Trouble with cement-lined service occurs most frequently from corrosion on the outside of the pipe, and especially where the pipe enters the cellar. In many cases the action on the outside of the pipe is quite rapid, and samples have been submitted to the committee where the iron has been completely eaten through and nothing but the cement remains to hold the water. This rapid corrosion is undoubtedly due to the dampness inside the cellar wall. Various methods have been suggested for remedying this. A short piece of the pipe where it passes through the cellar wall may be incased in cement. Another suggestion is that a coupling be placed just outside the wall, so that the corroded piece may be readily removed and replaced. Still another method is to put in a short section of brass pipe where it passes through the wall.

Size of Service

The standard size for services is ordinarily ¾ in., but in several cases this size has been increased to 1 in. or even to 1¼ in. for the purpose, chiefly, of lengthening the life of the service. Where plain or galvanized steel or wrought-iron pipes are used, the pipes soon fill up with rust, but the service which they render is fairly satisfactory until the pipes become nearly choked, when they must be cleaned. A 1-in. pipe has about twice the area of ¾-in. pipe and will probably last at least twice as long before it will require cleaning.

Rigid connections with the main and the omission of the goosenecks are used in a large number of places, and in some places such connections are used exclusively. Rigid connections make a considerable saving in the first cost, and are much more readily cleaned. On the other hand, the gooseneck permits the dropping of the service below the main and away from frost, and it is possible to make the service take any direction from the main.

Where rigid connections are used it is necessary to have a good soil in which the pipes will not settle, and it is necessary to have the pipes rest on a firm foundation, as any settlement in the service pipe near the main will cause the service to break. The digging up of the street near the main may also cause trouble to rigid connections. The fact that 83 of the towns reporting use rigid connections to a greater or less extent, and that 56 of these report no trouble and many others "little trouble" or "some trouble," would indicate that the use of rigid connections is thoroughly practicable.

During the past few years great advances have been made in the methods of cleaning service pipes, and it is now possible to save large sums which have heretofore been paid for digging up the services and for renewals. The committee has not discussed the merits of the different types of cleaners, but all of them seem to have some

merit. The most satisfactory in many cases, and especially with lead pipes or when goosenecks are used, is the force pump and wad of paper which permits the cleaning of the gooseneck and corporation cock as well as the straight pipe.

Method of Paying for Services

Custom varies as to the method of charging for services, but in New England the general custom is for the department to pay for the service from the main to the curb cock or to the property line, the remainder being paid for by the owner. Outside of New England the custom appears to be quite different, and in the majority of places making returns the customer is obliged to pay practically all of the cost of the service from the main to the house.

The almost universal opinion among superintendents, especially in New England, is that the water department should lay and maintain all the services from the main to the stop-and-waste in the cellar whatever portion of the expense may be borne by the department. The cities and towns in which this is not now done are comparatively few, and in these places the superintendents in many cases have expressed the opinion that it would be wise for the department to take charge of the entire service.

Building the Storm King Road

An extremely difficult piece of mountain-road construction between West Point and Cornwall Landing, N. Y., is now well under way.

This short stretch of road, only 4¼ mi. in length, is the last link needed to make a continuous highway on the west side of the Hudson River, between New York and Albany. The road has to be built along the steep rocky slopes of Storm King and Crow Nest mountains where there has never been even a footpath. These mountains slope steeply down to the river, where a narrow shelf has been blasted away for the tracks of the West Shore R.R.

So steep and inaccessible are some of the slopes along which the road has to be built that in making surveys for the road, cans of white paint were fired from a small cannon against the face of the cliff to make a mark at which the surveyors could direct their instruments. The surveys and plans for the road, made three years ago while John S. Carlisle was Highway Commissioner of New York, were described in *Engineering News*, Oct. 14, 1915, p. 721. A contract for a part of the road was let under Mr. Carlisle, but was annulled when Commissioner Duffey took office, as the plans on which the road was then being built promised to exceed the available appropriation. The work was readvertised and the contract let to the John L. Hayes Construction Co. on July 26, 1915, the contract price being $273,736.70 and the length of road 4¼ mi. Work started in the middle of August, 1915, and continued until the severe weather of December brought it to a close. It started again Apr. 1 and is now being prosecuted at four points on the north division of the project.

The road starts at Bay View Ave., Cornwall, and rises gradually along the side of the mountain to an elevation of 390 ft. above the river. About 800 ft. of this section has been rough-graded, and a small gang of men with a 10-ton derrick is now working. Work is also in progress at three other points, the gangs amounting to 120 men.

Last fall also about 2,400 ft. on the West Point end was rough-graded. The most work was done at the ravine between Storm King and Crow Nest. Here a 10x15-ft. stone culvert 154 ft. long was constructed. The fill over this culvert is 60 ft. high and contains 42,000 yd.

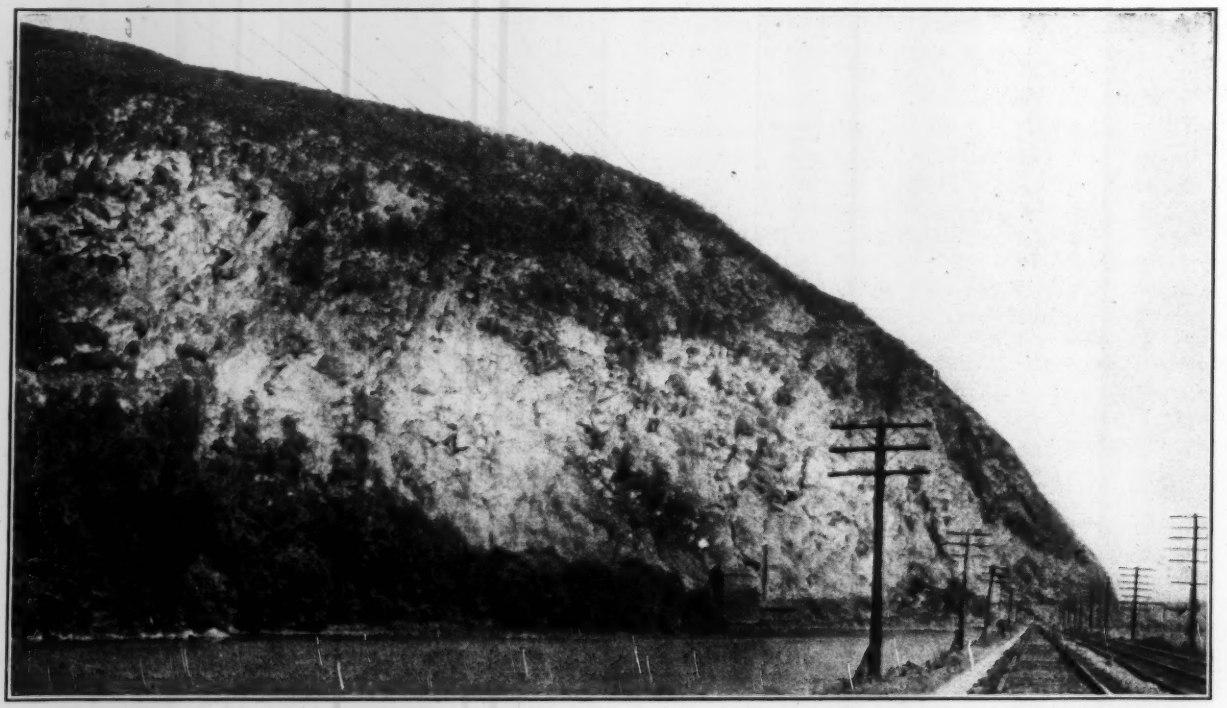


FIG. 1. STORM KING MOUNTAIN LOOKING SOUTH; ROAD LOCATED HALFWAY UP THE MOUNTAIN

FIGS. 2 TO 4. TWO VIEWS OF DRY MASONRY WALL CONSTRUCTION, AND THE LARGEST CULVERT

Just above this ravine fill a gang started blasting and building on Storm King in the direction of Cornwall. At the foot of the mountain is the abandoned Storm King rock crusher, the quarry property of which (exclusive of machinery) has been purchased by the state. Rock from the blasting fell upon the crusher building. Because of this, about the middle of August, an injunction was filed restraining the contractor from further work at this location.

The most difficult portion of the work at the present time is along the slopes of Crow Nest Mountain (Sta. 92-112). The ground here is very precipitous and rugged. Machinery can be moved forward at no faster rate than the advance of the road itself. This condition, though aggravated here, is by no means peculiar to Crow Nest, but is a very general condition and one that harrows the contractor.

The roadway is 24 ft. wide and the present plan is to pave it with 16 ft. of bituminous macadam. The road is nearly all in side-hill cut, the fill on the lower side being held by retaining walls, 10 to 50 ft. high. The footing courses of the retaining wall are laid up in mortar for a depth of 3 to 8 ft. and above that a dry wall is laid. These dry rubble walls are laid with a batter of 2 in. per ft. on the face and 4 in. per ft. on the back. A stone parapet laid up in mortar, with rough coping, is built on top of the wall. Weep pipes 4 in. in diameter are provided at 10-ft. intervals.

All the excavation is done by hand. Sand and cement for the footing mortar is delivered in bags by boat at several points along the river and is transported by hand across the West Shore R.R. tracks, and then carried up the mountain side either by mule and stone boat or by a hand-operated cable railroad having a maximum grade of 55%.

All the machinery is air operated. The compressor plant, located at Sta. 25, was purchased from the Oscar Daniels Co. and is one formerly used in building the Catskill Aqueduct. Mr. Hayes has not had to move the plant, having obtained a three-year lease for the ground on which it stands from the Board of Water Supply. The capacity of the plant is 1,400 cu.ft. per min. It is the Ingersoll "Imperial" type and electric driven. The 4-in. air line is 3 mi. long. In colder weather no difficulty is experienced with condensation. In the summer season, however, this is something of a problem. The air is of good quality on the high line, but the condensation is troublesome on the low line and numerous blow-offs must be provided. The connected load on the air line comprises 12 Jackhamers, two cranes, three hoists, four blacksmith forges and a steel-sharpening machine.

The slope on which the work is carried on is so steep that much of the rock blasted slides down onto the railroad tracks, sometimes breaking a rail. To minimize this danger, logs of greater diameter than the height of a 105-lb. rail are placed along all rails in the immediate vicinity of a blast. The railroad permits shooting at 8, 10:50 and 11:30 a.m., and at 1:45 and 4 p.m. On the right-of-way below where the work is being prosecuted on Crow Nest, there is a dispatcher's telephone and two local telephones for flagmen. Another local telephone has been installed for the contractor on the mountain. Prior to a blast a barricade is built below the line of the road. This has some effect in checking the fall of material. Barring down has been tried instead of blasting, but much rock slid down the mountain, just the same.

On Crow Nest Mountain about 350 ft. of road has been rough-graded (extremely rough) and this particular strip has required three months' work. On this section the rocks are handled by a two-drum valveless hoist built by the Dake Co. This machine weighs only 1,200 lb. and lifts one ton on a single line and three or four tons with a double block.

John L. Hayes is in personal charge of the work, his superintendent being A. C. Perkins. J. L. Wissing is county assistant and is located at Cornwall Landing.

World's Busiest Street—On Fifth Ave. at 42nd St. the heaviest traffic of any city in the world exists according to a recent count. Between 3:30 and 4:30 p.m. 1,149 vehicles were counted proceeding south. The top figure for the Strand, London, is 900 vehicles per hour, and in Paris, the record is 600 in an hour on the Boulevard de Capucines.—E. W. Stern, in Annual Report of Bureau of Highways.

Refuse Incinerator for Queens Borough, New York City

By J. C. Woodman*

SYNOPSIS—A 100-ton all-steel water-jacketed Decarie plant that at medium temperature and with forced draft burns refuse consisting largely of garbage without the use of commercial fuel.

A refuse destructor with a daily capacity of 100 tons was put into operation in April, 1916, by the Borough of Queens, New York City, and has since been consuming a very wet mixture of refuse without the use of any commercial fuel whatever and without creating any nuisance to the surrounding residence districts. The destructor is of the Decarie all-steel water-jacketed design. Kelly & Kelley, Long Island City, were the successful bidders for the installation at $98,700, and the machinery was furnished and set up by the Decarie Incinerator Co., of Minneapolis, Minn.

In the selection and installation of the destructor the Borough of Queens was represented by Daniel Ehntholt, Commissioner of Street Cleaning, and by Hans Liebau, Architect of the Borough.

*Superintendent of Construction, Decarie Incinerator Co., Minneapolis, Minn.

The plant (Figs. 1 and 2) consists of two 50-ton units very similar in design and arrangement to a single unit of the same capacity at Roanoke, Va., described in *Engineering News* of Apr. 8, 1915. The distinctly sanitary feature of the plant is the absence of any storage bins. All material coming for destruction is dumped from the wagons on the upper floor of the building directly through a hopper opening in the floor. Each unit is capable of holding 16 cu.yd. of refuse at one time without in any way tending to smother the fire. This is possible because of the patented basket-grate construction, which is a distinctive feature of this type of plant and which was described in the article on the Roanoke plant, already mentioned.

Each unit is independent of the other, so they can be operated simultaneously or separately. Each unit has its gas-combustion chamber, preheater, induced- and forced-draft fans. The forced-draft fans are No. 110 Special American Blower Co. fans, and the induced draft fans are No. 8 Sirocco fans made by the same firm. All fans are driven by steam engines, the steam being generated in the water jacket of the furnace by the burning garbage. An electric motor drive is also provided for the

FIG. 1. VIEW OF QUEENS BOROUGH INCINERATOR, NEW YORK CITY, FROM LOWER FLOOR

forced-draft fans to be used in starting up the plant, but to date (July 8, 1916) it has not been found necessary to use these motors at all.

The chimney is of radial brick construction, 6 ft. in diameter by 150 ft. high; lined to the top. The building is of heavy brick construction with concrete floors and Spanish tile roof. The wagons enter from the street to the upper floor over a reinforced-concrete approach 18 ft. wide and 209 ft. long.

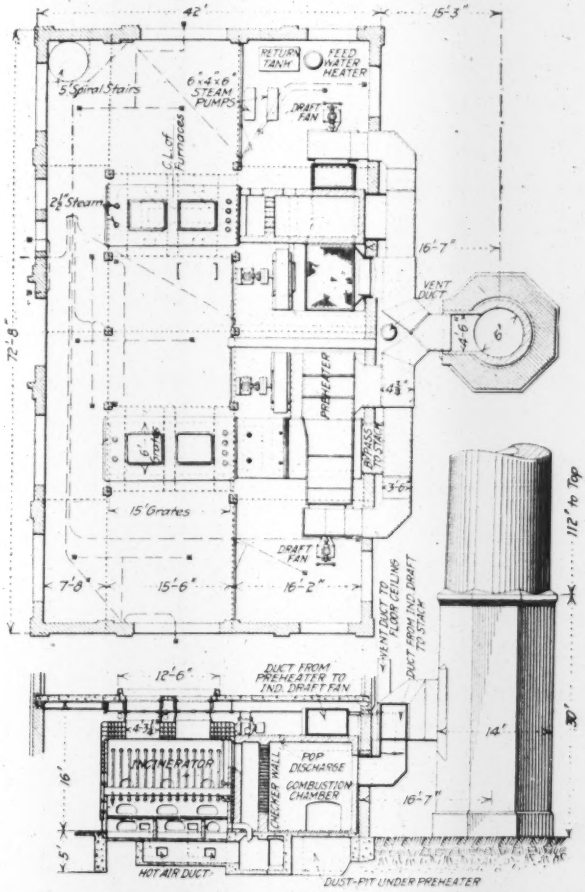


FIG. 2. GENERAL PLAN AND CROSS-SECTION OF QUEENS BOROUGH REFUSE INCINERATOR

The most distinctive results obtained by this destructor are the low cost per ton consumed, due to the small amount of labor necessary, and the ability to consume the material without the use of fuel (see accompanying table). The guarantees given by the bidders were substantially as follows:

A capacity to consume at the rate of 50 tons in 24 hr. in each unit operating separately, or to consume 100 tons in 24 hr. when both units were operating.

The material to be consumed to be as collected from day to day by the city carts in the Ridgewood section and to be on the average a mixture of about 70% wet garbage to 30% of rubbish.

That all materials would be consumed to a mineral ash practically free from organic material.

That the plant in its operation would cause no nuisance through the escape of obnoxious odors, gases or dust from either the building or the stack.

That the cost to operate the plant, including all labor, supervision and fuel necessary when both units were working, would not exceed 60c. per ton, and with either single unit operating not more than 75c. per ton; labor to be figured at $3 per 8-hr. day and supervision at $4.50.

That the cost per ton under the same conditions as above, only also including the cost of electric current necessary to operate the forced-draft fans, would not exceed 80c. and 97c respectively.

These guarantees were covered by a $62,000 bond, which has been returned since the plant has been officially accepted by the city. The results of the official test made under supervision of a committee of the Board of Estimate of New York City were as follows:

RESULTS OF TEST ON DECARIE INCINERATOR PLANT AT RIDGEWOOD, BOROUGH OF QUEENS, NEW YORK CITY, MAY, 1916

Date of test	May 8	May 10	May 15
Unit tested	No. 1	No. 2	Nos. 1 and 2
Weather	Clear	Clear	Clear
Duration of test, hr.	17	15.5	17.5
Mixed refuse consumed, lb.—garbage	74,770	71,325	141,681
Mixed refuse consumed, lb.—rubbish	30,585	29,990	60,330
Total material consumed, lb.	105,355	101,315	202,011
Rated capacity of units operated, tons per 24 hr.	50	50	100
% of material, garbage	70.9	70.3	70.1
% of material, rubbish	29.1	29.7	29.9
Refuse consumed per hour, tons	3.09	3.26	5.77
Equivalent incineration in 24 hr., tons	74.16	78.24	138.48
Equivalent incineration per square foot grate per hour, lb.	69.67	72.4	64.1
Labor cost as per terms of contract	$22.31	$20.35	$36.09
Labor cost per ton as per contract	42.3c.	40.1c.	35.7c.
Actual labor cost as operated by the city	$28.69	$26.16	$42.65
Actual labor cost per ton as operated by the city	54.5c.	51.6c.	42.2c.
Cost of fuel required per ton	0	0	0
Total cost of operation per ton as per terms of contract	42.3c.	40.1c.	35.7c.
Total cost of operation per ton as actually operated	54.5c.	51.6c.	42.2c.
Guaranteed cost of operation per ton	75c.	75c.	60c.
Condition and amount of smoke	Light white	Light white	Light white
% carbon in free state in the clinker	5.39*	6.58*	1.13
% of ash and clinker produced	9.3	10.7	12.3
Average temperature in combustion chamber of No. 1 unit, ° F.	1,040	....	1,290
Average temperature in combustion chamber of No. 2 unit, ° F.	....	1,161	1,340
Maximum temperature in combustion chamber of No. 1 unit, ° F.	1,580	....	1,650
Maximum temperature in combustion chamber of No. 2 unit, ° F.	....	1,600	1,810
Average temperature of forced draft beneath grates	391	496	510
Average stack draft, in. of water	0.94	0.99	0.98
Average steam pressure on No. 1 unit, lb. per sq.in.	86.2	....	96.0
Average steam pressure on No. 2 unit, lb. per sq.in.	....	93.7	90.0

*The higher percentage of carbon in these two tests was due to the fact that the units were being overloaded to far above capacity, as rate of combustion per square foot of grate will show as compared with rate of combustion in third test, May 15.

The plant exceeded its capacity by 48 to 56% with units operating separately and by 38.5% when both units were working, burning as high as 72.4 lb. of this wet mixture per square foot of grate per hour without any fuel or ashes to help maintain the temperature. The plant is capable of consuming any class of material, wet or dry, or with ashes mixed in with the other refuse.

The analysis of the gases leaving the stack from time to time showed an average of about 6 to 8% of carbon dioxide, an excess of free oxygen of about 16% (due, of course, to the fact that the plant has forced draft), together with a trace of sulphur dioxide. There was no carbon monoxide or hydrogen sulphide present—which, with the absence of any dark heavy smoke, indicated freedom from gases that could cause any nuisance.

The cost per ton to operate under the actual working conditions was from 30 to 40% under the guaranteed costs. The cost, including the electric power, was of course fully met, as no electric power has been necessary to date.

The average temperatures in the gas-combustion chambers show that this type of plant is between the so-called high-temperature class and the slow-burning low-temperature type of plant. The temperature in the furnace proper greatly exceeds this shown, as tin cans, bottles, crockery, dirt, etc., are fused into a vitreous clinker.

The most striking feature is that these temperatures could be maintained without having any ashes in the refuse and without using any commercial fuel whatever, even when handling material 70% wet garbage, some of which had been stored on the ground in the rain for several hours. The hot forced draft is an essential feature that helps to obtain these results and to save fuel that might otherwise be necessary.

Complete combustion of the gases is obtained in this plant by maintaining temperatures sufficiently high to ignite these gases and by introducing into the combustion chamber a small stream of hot air from the forced-draft fan so as to get a complete chemical action before the gases reach the stack. Unnecessarily high temperatures are avoided because of a greater maintenance expense that is created when these are produced. An excess of steam over that necessary to operate the plant is generated, and in this installation a small portion of it will be used to heat adjacent city buildings.

Post-Mortem Appraisal of Industrial Plant

By Charles H. Higgins*

The greatest field for post-mortem examinations is in medical science; but in engineering, accounts of them are common after a physical failure, and from them we learn much. There is another kind of failure, to which engineering construction is particularly susceptible, that is equally instructive when the remains are carefully and scientifically examined—the financial failure.

The financial failure of industrial plants is probably as common as their physical failure and may, in fact, be due to the latter. Although the failure to function properly is not so dramatic as a complete physical collapse of a structure, it is not less to be guarded against in design.

A feeling of responsibility and the consequent study of this economic side of the design are perhaps as much as anything what as a rule distinguish the design of the engineer from that of the architect. Consequently, an analysis after financial failure, while no more cheering, may be equally instructive with the analysis so common after physical collapse.

For the reasons mentioned, the analysis of the physical property of a certain industrial plant, which was closed through bankruptcy, is here presented. In common with most descriptions of failures this is not complete, but from the facts presented, suggestions made may be taken to guide the designer of other industrial plants.

The prospectus of the Traders Paper Board Co. appeared in June, 1906, and the plant was constructed during that year. Its history during the latter part of 1907 was one of difficulties not uncommon to industrial plants. But the struggle went on, and it was not until early in 1912 that the property was to be sold by the trustee in bankruptcy, and that the referee appointed appraisers to make an inventory and valuation. The author was one of the appraisers and compiled the unanimous report, the other appraisers being Frank B. Stratford and Charles Behlan.

The plant of the Traders Paper Board Co., as suggested by the name, was built for the purpose of manufacturing the material from which card-board or paste-board boxes are manufactured. The principal raw material used was waste paper.

The following paragraphs from the prospectus of the company are illuminating:

> Capital Investment—The low capital investment of the company, in proportion to its daily output, will afford it an additional advantage over all its competitors. The capital invested in all other similar plants of the country, so far as

*Consulting Engineer, 30 Church St., New York City.

TABLE 1. DETAILS OF APPRAISAL; TRADERS PAPER BOARD CO.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Buildings	Net Cost	Net Cost plus 12%	% Scrap	Scrap Value	Wearing Value	Av. Life	Elapsed Life Years	% of Dep.	Depreciation	Present Value as Going Concern	Annual Dep. Str. Line Basis
No.	2 Wells	7,449	8,387			8,387		5	75	6,290	2,097	
	3 Reservoir	1,140	1,277			1,277		5	50	639	638	13
	4 Dock	4,329	4,848			4,848	25	3	12	582	4,266	261
5, 6	Intake, drain	1,525	1,708			1,708	50	5	10	171	1,537	34
	7 Concrete buildings	164,284	183,998			183,998	50	5	10	18,500	165,598	3,680
	8 Frame buildings	1,741	1,950			1,950	20	8	40	780	1,170	98
	9 Spec. found.	9,500	10,640			10,640	25	5	20	2,128	8,512	426
	10 Elevators	2,350	2,632	5	132	2,500	25	5	20	500	2,132	100
	11 Fire protection	4,768	5,330	3	160	5,170	25	5	20	1,034	4,296	207
	12 Air lift	7,700	8,624	6	517	8,107		5	75	6,080	2,544	102
	13 Heating	8,000	8,960	5	448	8,512	25	5	20	1,702	7,258	340
	14 Lighting	3,145	3,522	8	282	3,240	15	5	33⅓	1,080	2,442	216
		215,951	241,878		1,489	240,337				39,386	202,490	5,477
	Power Plant											
	15 Coal machine	4,950	5,544	5	277	5,267	15	5	33⅓	1,756	3,788	385
	16 Boilers	15,800	17,696	7	1,239	16,457	15	5	33⅓	5,486	12,211	1,097
	17 Economizers	12,825	14,364	6	862	13,502	30	5	16⅔	2,250	12,114	450
	18 Stacks	744	833	5	42	791	15	5	16⅔	132	701	26
	19 Engines	18,781	21,035	7	1,472	19,563	25	5	20	3,913	17,122	783
	20 Generators	2,730	3,058	10	306	2,752	20	5	25	688	2,370	138
	21 Pumps	7,509	8,410	6	505	7,905	25	5	20	1,581	6,829	316
	22 Motors	1,815	2,033	10	203	1,830	15	5	33⅓	610	1,423	122
	23 Wiring	2,350	2,632	11	290	2,342	15	5	33⅓	781	1,851	156
	24 Piping	36,742	41,151	7	2,881	38,270	25	5	20	7,654	33,497	1,531
		104,246	116,756		8,078	108,679				24,851	91,906	5,000
	Paper-Making Machinery											
25, 26												
	27 Dusters, etc.	1,775	1,988	3	60	1,928	15	5	33⅓	643	1,345	129
	28 Beaters	14,211	15,916	4	637	15,279	15	5	33⅓	5,093	10,823	1,110
	29 Jordans	4,166	4,666	6	280	4,386	25	5	20	877	3,789	175
	30 Stuff pipes	800	896	2	18	878	6	3	50	438	458	6
	31 Stuff chests	6,816	7,634	1	76	7,558	15	5	33⅓	2,519	5,115	504
	32 Pumps	3,600	4,032	6	242	3,790	16	4	25	948	3,084	190
	33 Shafting	6,002	6,722	12	807	5,915	25	5	20	1,183	5,539	237
34, 35	Cranes, scales	2,451	2,745	5	137	2,608	25	5	20	522	2,223	104
	36 Screens	4,118	4,612	4	184	4,428	15	5	33⅓	1,476	3,136	295
	37 Paper machine	85,745	96,034	6	5,762	90,272	25	5	20	18,054	77,980	3,611
38, 39												
	40 Binder-cutter	2,500	2,800	5	140	2,660	20	4	20	532	2,268	106
	41 Belts	3,279	3,672	10	367	3,305	2	1	50	1,653	2,020	1,653
		135,463	151,717		8,710	143,007				33,938	117,780	8,120
	Grand total	$455,660	$510,349		$18,277	$492,023				$98,175	$412,176	$18,601
Per ton daily capacity		9,114	10,207							1,964	8,244	372

can be ascertained, is from $10,000 to $30,000 per ton of daily output. One of the plants most recently erected and now conducted upon a very profitable basis shows a capital invested of $10,000 per ton. The capital invested by the Traders Paper Board Co. will be only $6,800 per ton, and even this is based upon buildings and equipment designed for a larger capacity, which, when added, will reduce the capital invested to $5,000 per ton of daily output.

Estimated Profits—In estimating the probable cost of manufacture, the company has based its figures upon the long and practical experiences of Mr. Ivins, thus assuring that no important item of cost will be ignored or under-estimated. Mr. Ivins has furnished to the company the following estimate [cost of production of the cheapest and least profitable grade of paper boards]:

	Per Ton	Per Ton
Cost of raw material		$8.00
Cost of manufacture:	Per Ton	
Labor	$3.50	
Felts	.25	
Twine	.10	
Insurance	.10	
Taxes	.20	
Belting	.15	
Repairs	.80	
Oils	.08	
Fuel	2.65	
		7.83
All expense of management and sales		1.40
Total, f.o.b. Bogota		$17.23

Table No. 2 is a summary of the appraisers' report, and the item "Deduct 40% for forced sale and lack of going-concern element" tells its own tale of a shut-down plant.

TABLE 2. APPRAISAL OF TRADERS PAPER BOARD PLANT, BOGOTA, N. J., APRIL, 1912

Summary

Land		$13,480
Building and appurtenances		202,490
Power plant		91,906
Paper-making machinery		117,780
Tools		1,384
Repair parts and tools		10,992
Office furniture and fixtures		992
Present value as going concern		$439,024
Deduct 40% for forced sale and lack of going-concern element		175,610
Actual present value at forced sale		$263,414
Raw materials	$8,521	
Finished stock	8,300	
	$16,821	
Deduct 25% for forced sale	4,205	
		12,616
Total actual present value at forced sale		$276,030
Built, except small part noted, in		1906
Total cubic feet of buildings of all kinds		2,083,000
Total square feet of buildings of all kinds		103,000
Total horsepower, engines		1,200
Total horsepower, boilers		1,600
Total capacity in tons per day of paper board		50
Actual present value per ton of daily capacity		$5,528

The property sold at auction by the trustee for close to the figure named as the "Total actual present value at forced sale." The view from the wash-drawing perspective published in the prospectus, illustrates fairly well the appearance of the plant when constructed and at the time of the appraisal.

Table 1, from which the principal items in Table 2 are drawn, gives in condensed form the details of cost, scrap value, life, depreciation, present value as a going concern and annual depreciation.

Numbers in the first column of Table 1 refer to sections in the appraisers' report, where the items named in the second column are described and where the cost given in column 3 is arrived at through quantities and unit prices. Section 2 of the appraisers' report reads as follows:

2. Wells—Six deep wells, said to be from 354 to 420 ft. deep, and one well 128 ft. deep, with 7-ft. screen between 31 and 38 ft. Total, 2,483 lin.ft.; about 40 ft. through drift into sandstone. Each of former said to have shown in test by well drillers 35 to 40 gal. per min. separately, and the latter 20 gal. per min.; 8-in. casing. None of the wells has been in use for a considerable time.

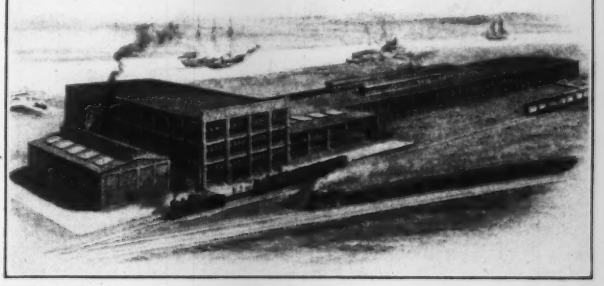
Wells, 2,483 lin.ft. @ $3, $7,449.

These wells did not meet expectations as to quantity of water and their use was discontinued. This condition is indicated in column 10 of Table 1 by the high depreciation fixed by the appraisers, to whose minds at the same time there appeared an element of value remaining, as indicated in column 12. Here we have an example of functional depreciation, which appears again in Sections 3 and 12, "Reservoir" and "Air Lift," these devices having been installed for use in connection with the wells. The other items in column 12 indicate depreciation from use—that is to say wear and tear.

Column 4 shows the cost arrived at by adding 42% to the net cost, column 3, this percentage covering overhead charges, such as design, supervision, interest, etc. The scrap values in column 6 deducted from the sums in column 4, give the wearing values in column 7. This represents the amount of investment which is fixed in the plant and can only be returned through operation.

In column 8 are set down the appraisers' estimate of the average life of each group. These simple figures will not be passed over lightly, as on them is largely dependent the final results. Varying as they do in the table from 2 to 50 years, the determination of them draws more heavily on the judgment than any other figures in the table.

The figures in columns 10, 11 and 12 follow naturally from 7, 8 and 9, and bring us to the annual depreciation of each group, shown in column 13. Now, this is the real cost to be borne annually and, taken with columns 4 or 7, is of the greatest interest to the designer in making studies for a truly efficient design. For example, "No. 24, Piping," which cost $11,151, resulted in a lower annual



PLANT OF TRADERS PAPER BOARD CO., BOGOTA, N. J.

charge than belting, which cost $3,672—that is to say, $1,530 as against $1,653 per year.

It will be noticed that the plant is divided under three heads—"Buildings," "Power Plant" and "Paper-Making Machinery"; it is interesting to observe that in a plant for a highly specialized purpose the general items of "Building" and "Power Plant" amount to more than double the special item of "Paper-Making Machinery," illustrating how much of a plant for a highly specialized process is, after all, made up of general items common to industrial plants.

Nor should the last item at the foot of the table be overlooked, for here we find cost reduced to terms most clearly illuminating the purpose—namely, cost in terms of producing capacity. In the table, capacity is given in tons per day of 24 hr., while the annual depreciation charge is given in dollars per year. But if we estimate 300 work-

ing days in the year, we find a cost of $1.25 per ton of production.

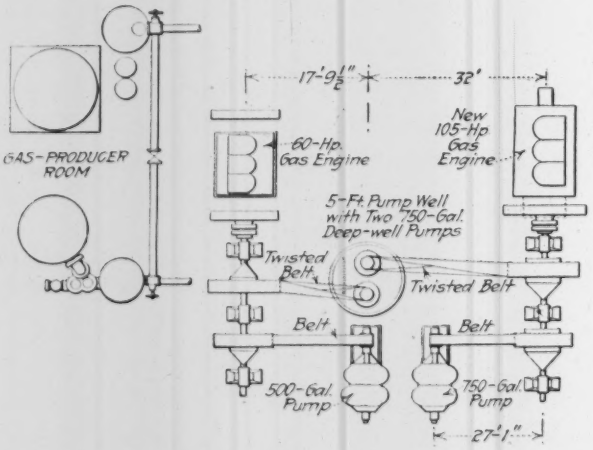
It is interesting to compare this with the figures quoted from the prospectus and to notice how small the item of $1.25 per ton appears as compared with $17 per ton for other charges. The fact, however, cannot be lost sight of that this is a fixed charge, practically independent of the volume of production, and it is not, unlike the other items, to be escaped by closing down the plant. It may be noted that, when the plant was again operated, this item had been cut in half through the property having been bought at the sale for about one-half the original outlay, as mentioned at the beginning.

These are only a few of the interesting things to be gathered from a table arranged in such fashion; and any person, whether designer or owner, with such a table before him for the plant he is proposing to build, will appreciate much better the difference between cheapness and economy and may design for true saving of expense instead of either running into extravagance on the one hand or parsimony on the other. Between them lies the path to the truly efficient design of industrial plants.

Producer-Gas Engines Drive Water-Works Pumps

The City of Wheaton, Ill. (population 4,000), is making improvements in its water-works system so as to give both increased supply and greater pressure. The city is mainly of a residential character, and is about 25 mi. west of Chicago. Its average daily consumption is 300,000 gal., with a maximum record of 510,000 gal.

The water is obtained from two 10-in. wells, 175 ft. deep, the bottom being in rock for about 65 ft. These



PLAN OF PRODUCER-GAS PUMPING PLANT FOR THE WATER-WORKS AT WHEATON, ILL. (NOT TO SCALE)

wells penetrate a local deposit of glacial drift about 100 ft. deep which constitutes a natural reservoir. This drift is underlaid by Niagara limestone, which contains numerous fissures and cavities that are filled with water from the overlying sand and gravel. Neighboring cities which are not on this body of drift require wells about 2,000 ft. deep.

The water level in the drift is about 26 ft. below the surface, and when the pumps are working the water in the wells is about 66 ft. below the surface. The water level has had the same elevation for several years, but it was feared that with increased pumping it might be lowered. At several cities in the northern part of the state, where the water is drawn from deep wells, such a depression of the water table has been observed due to increased pumpage. In these cases, however, the supply is taken from the St. Peters and Potsdam sandstones.

Investigation indicates that there is no liability of serious depression of water level at the Wheaton water-works, since the comparatively shallow wells have such a large body of water to draw upon. If deep wells were sunk, as had been proposed before the investigation was made, these would have probably a much lower water level, while draft on the supply in the lower water-bearing formations which they would tap will be steadily increased in future by additional deep wells in adjoining communities. It was recommended therefore that the city should continue to draw from the wells in the drift rather than sink deeper wells in the underlying rock strata.

The two 175-ft. wells are 20 ft. apart, and about midway between them is a brick-lined pump well 5 ft. in diameter and 34 ft. deep. In this well is an American Well Works vertical-shaft centrifugal pump with a capacity of 600 gal. per min., and having 6-in. connections to the two supply wells. This pump discharges into a covered concrete surface reservoir approximately 32 ft. square and 17 ft. deep, having a capacity of about 116,000 gal.

The total head is only 65 ft., against which the pump delivers about 680 gal. per min. The pump was designed, however, for a capacity of 520 gal. against a total head of 200 ft. in order to enable it to pump directly into the mains under 215 ft. head if necessary. This would give about 30 to 35 lb. fire pressure. The pump is driven from a Nash vertical three-cylinder gas engine of 60 hp., which is supplied with gas from a 75-hp. producer of the suction type, built by R. D. Wood & Co. The producer burns pea-anthracite coal, costing about $5.50 per ton in the bin at the plant. A twisted belt runs over pulleys on the horizontal shaft of the engine and the vertical shaft of the pump.

A service pump, belted to the gas engine, delivers water from the reservoir to a standpipe, 14 ft. in diameter and 120 ft. high, having its top 130 ft. above the mains. This reservoir has a capacity of 138,000 gal. It was built in 1890. The pump can deliver 650 gal. per min. with the standpipe full.

With only one engine and pump there is a risk of trouble from breakdown, and the pumping plant is now being enlarged so as to provide two separate units. For this purpose an additional Nash gas engine (with its own producer) is to be installed, and the present well pump will be replaced with two larger vertical-shaft pumps built by the American Well Works. The new engine, built by the National Meter Co., of New York, will be of 105 hp., having three vertical cylinders 13x16 in., and running at 250 r.p.m. It will be served by a gas producer of 125-hp. capacity, of the Sharpe-Bassett type, built by the Reliance Boiler Works, of Milwaukee, Wis. The well pumps will be driven by twisted belts, as formerly, and the plant is so arranged that either engine can drive one of the pumps. The accompanying drawing shows the layout of the new plant.

Each of the new well pumps will have a capacity of 750 gal. per min. against 70 ft. total head. They will have 8-in. suction connections to the supply wells and 8-in. discharge pipes. There will be also two service pumps, one of 500 gal. and the other of 750 gal. per min. capacity. Each gas engine will drive a well pump and a service pump, the new engine driving the larger pump. This arrangement will give a total pumping capacity of 1,250 gal. per min. when necessary, and the head will deliver four 70-ft. fire streams of 250 gal. per min. at the center of the city. An electric sump pump will be provided for keeping the pump well dry.

A water tower with elevated steel tank of 200,000-gal. capacity is to replace the present standpipe, the latter being located on low ground while the base of the tower will be 19.2 ft. higher than the base of the standpipe. The tower is 138 ft. high from the piers to the circular girder around the base of the tank. The tank itself is 28 ft. in diameter and 34 ft. high in the cylindrical portion, with a segmental bottom 11 ft. deep and a conical steel roof. The Memphis Steel Construction Co., of Greensburg, Penn., has the contract for the tank.

The purchase of electric current for pumping was proposed, but was not adopted for reasons of cost and the fear of possible interruption of the supply at some critical time. A new brick pumping station is to be built, 18x90 ft. Its floor will be about 12 ft. above the present floor level, with concrete piers for the two engines. The building will have a curved roof carried on McKeown wood lattice trusses.

When the present 34-ft. pump well was put down, a few years ago, the water from the supply wells broke in and caused considerable trouble before the well could be completed and sealed. The bottom of the well is plugged with concrete. In trying to keep this well pumped out, large quantities of sand were discharged by the pump, causing surface settlement which threatened to be serious. The cavity was filled up later, but as its extent is not known definitely it was considered inadvisable to put columns on this fill, and part of the pumping station will be carried by girders spanning the fill.

The cost of the improvements will be about $35,420, apportioned as follows: Water tower, $8,843; foundations for tower, $1,071; gas engine and producer, $8,237; pumps, belting, etc., $4,695; 1,700 ft. of 12-in. main to connect with new water tower (including pipe laying), $3,518; pumping station, $9,056. The engineer's estimate was $35,000, but between the making of the estimate and the letting of contracts there were important increases in market prices. The cost will be paid out of a bond issue. The water-works improvements were designed by L. J. Ruddock, City Engineer, and are being carried out under his direction.

Operating Results of Cleveland Municipal Lighting Plant

The municipal electric lighting plant of Cleveland, Ohio, furnishes current at a maximum rate of 3c. per kw.-hr. and has now been in operation for over two years. A description of the plant was published in the issue of July 30, 1914, and a brief review of the financial results obtained during its first year of operation, Oct. 28, 1915, p. 859.

In the *Utilities Magazine* for July, Frederick W. Ballard, the former Commissioner of the Cleveland Light Department, who designed and built the plant and was in charge of its operations up to Jan. 1, 1916, reviews the financial results of operation and shows that at present the plant is earning a large profit over and above its fixed charges. Mr. Ballard is this year President of the Cleveland Engineering Society.

During the first year of its operation, as usually happens in starting a new public utility, the profits of the Cleveland plant were insufficient to meet the fixed charges, owing to the length of time required to take on customers sufficient to give the station a paying load. The results for the entire year 1915, however, were very satisfactory. They are summarized by Mr. Ballard as follows:

Gross revenues		$528,856
Operating expenses:		
Generation of current	$112,578	
General office expense	33,786	
Distribution of current	139,391	
Damage claims paid	7,340	
Overhead charges from city administration	13,000	
Interest to Water Department for use of land	5,040	
Total operating expenses		311,135
Net revenue		$217,721

Mr. Ballard states that the investment in the plant is just about $3,000,000. He estimates fixed charges on this investment as follows:

Taxes at 1½% on $3,000,000	$45,000
Interest on bonds	119,850
Depreciation at 3%	90,000
Total fixed charges	$254,850

While the net earnings for the year 1915, as shown, are somewhat below the fixed charges, there has been a great increase in the revenues in the past year, the earnings for January, 1916, being nearly double those of January, 1915, and the plant is now earning a handsome surplus. The financial results for the first quarter of 1916 were:

Revenue	$188,045
Operating expenses	21,919
Net revenue	$166,126

It will be seen from these figures that for the first quarter of 1916 the Cleveland municipal lighting plant made net earnings over operating expenses at the rate of $665,000 per annum and showed profits at the rate of $210,000 per annum after paying the fixed charges on the capital invested in the plant. It should be noted that these fixed charges include a 3% charge for depreciation and a tax rate at 1½% on the full value of the property, which is probably a larger tax than the city would actually receive if the plant were owned by a private company instead of by the city.

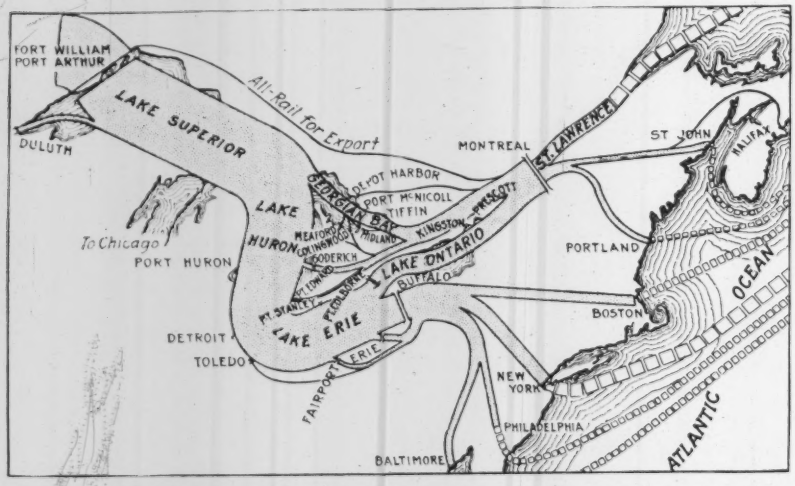
Mr. Ballard's estimate of fixed charges, moreover, errs if anything on the side of unfairness to the plant. The outstanding bonds issued against the plant are only $2,770,000, and of this amount $200,000 was applied to the construction of an ornamental street-lighting system that was not a necessary part of the municipal lighting plant.

Mr. Ballard states that the competition of the municipal lighting plant with the Cleveland Electric Illuminating Co. has reduced the rate charged by the company on street lamps by about $20 per year, and has also reduced the rate charged by the company to users of current for power and lighting, so that the total saving to the citizens of Cleveland resulting from the building and operation of their municipal electric light plant he computes to be $1,085,209 per annum.

Traffic Routes from the Lakes to the Seaboard

For more than 75 years one of the big problems of the engineering profession in America has been that of economic transportation between the Great Lakes and the Atlantic seaboard. The first great engineering achievement in this field was the completion of the Erie Canal in 1825. A generation later came the building of the trunk-line railways and, on the Canadian side of the boundary, the construction of the Welland and St. Lawrence canals, which enabled Lake vessels of moderate size to pass from the upper Lakes to tidewater at Montreal.

Near the close of the last century there was general discussion of larger water routes from the Lakes to the seaboard. The United States expended nearly a million dollars making surveys for a deep waterway from Lake Erie to tidewater at New York, some of the routes being across New York State to the Hudson at Albany, and others down the St. Lawrence, thence by canal to Lake Champlain and southward to the Hudson. This project was abandoned, however, when the State of New York undertook the construction of the New York Barge Canal, now nearing completion.



MAP SHOWING EASTWARD MOVEMENT OF CANADIAN WHEAT IN 1913 AND A STATEMENT OF DISTRIBUTION THROUGH OCEAN PORTS

Canadian Ports	Bushels	United States Ports	Bushels
Montreal	26,834,373	Portland	8,223,463
St. John	7,666,998	Boston	14,334,932
Halifax	554,712	New York	22,616,905
		Philadelphia	12,797,843
Total	35,056,083	Baltimore	12,690,009
		Total	70,663,152

STATEMENT OF DISTRIBUTION TO INTERIOR PORTS

	Bushels
From Fort William and Port Arthur via Great Lakes	130,181,954
From Duluth via Great Lakes	7,830,740
Total	138,012,694

	Bushels		Bushels
To Chicago	374,967	To Detroit	15,000
To Depot Harbour	2,963,915	To Toledo	950,525
To Port McNicoll	7,774,110	To Port Stanley	340,302
To Tiffin	11,639,728	To Fairport	5,198,205
To Midland	630,000	To Erie	7,628,824
To Collingwood	337,869	To Port Colborne	20,806,527
To Meaford	110,000	To Buffalo	54,643,639
To Goderich	6,608,085	To Kingston direct by water	1,972,473
To Port Huron	3,992,437	To Prescott	80,059
To Port Edward	386,142	To Montreal	11,559,887

	Bushels
Total Canadian ports	65,209,097
Total United States ports	72,803,597
Total Canadian and United States ports	138,012,694
By all-rail for export via Canadian Pacific Ry.	1,030,000

At about the same time a project was developed in Canada for building the Georgian Bay canal, a waterway from the northern portion of Lake Huron to the headwaters of the Ottawa River, and following down that stream by a system of slack-water navigation to Montreal. The surveys for this canal, completed in 1908, provided for a waterway 22 ft. deep and 440 mi. long, the estimated cost of which was $125,000,000. No action was taken by the Canadian parliament upon this project at the time the report of these surveys was presented; but five years later, in 1914, a commission was appointed to investigate the question whether or not it would pay Canada to spend $125,000,000 upon this work.

The chairman of this commission was W. Sanford Evans, of Winnipeg. A progress report just presented by Mr. Evans contains the most complete investigation of traffic conditions between the Canadian Northwest and the seaboard that has ever been made. While some studies in the same field were undertaken by the United States Deep Waterways Commission in 1898 and by the New York State Barge Canal Commission in 1900, the figures then obtained do not apply to present-day conditions. Mr. Evans' report is one that will be in general demand for engineering reference libraries. The full title of Mr. Evans' report is, "Statistical Examination of Certain General Conditions of Transportation Bearing on the Economic Problem of the Proposed Georgian Bay Canal." These "general conditions of transportation" are of interest not only as bearing on the question whether a Georgian Bay canal would be a paying enterprise, but because they have direct relation to the conditions in other transportation routes, existing and proposed. The investigations of waterways from the Lakes to the seaboard made 20 years ago developed the fact that at that time the export-grain traffic from the Lakes eastward was rapidly decreasing. When the upper Mississippi Valley was first settled and began pouring its vast crops of grain to market, there was a huge surplus of this grain available for export. The rapid growth of population in eastern cities, however, with the opening of new outlets for export grain at New Orleans and Galveston, materially reduced the volume of Western grain flowing eastward by way of the Great Lakes and was undoubtedly one reason why the United States lost interest in its projected deep waterway.

Conditions have again been radically altered by the enormous development of wheat-growing in the Canadian Northwest, since the beginning of the present century and especially in the last half-dozen years. Mr. Evans' statistics show that in 1913 there were 145,000,000 bushels of Canadian wheat brought to elevators at Port Arthur and Fort Williams as against 66,000,000 bushels in 1909.

As to the future increase in the production of wheat in the Canadian Northwest, Mr. Evans says it is impossible to set a limitation. "There is more wheat-growing land in western Canada that can by any stretch of probability be turned to account within a generation or two. The amount of wheat produced in that region, therefore, will simply depend on the market demands. In the past, out of every seven bushels of flour shipped by all exporting countries, Europe has absorbed a little over six bushels."

The great bulk of this Canadian wheat crop must find its final market across the ocean. The less the cost of transportation between the farms in the Canadian Northwest and the final purchaser in Europe the higher will be the price the Canadian growers will receive and the better the chance for the Canadian wheat in competition with wheat from Argentina, India and Russia. Canada is further interested in having as much as possible of this wheat carried to the seaboard over Canadian transportation lines and shipped through Canadian ports. The question that most interests Canada, therefore, is whether the proposed Georgian Bay canal would reduce the total cost of transport and whether it would restore to Canadian ports some of the Canadian wheat that is now diverted to routes through the United States.

Flow of Wheat to the Seaboard

There is reproduced herewith from Mr. Evans' report a map on which the flow of Canadian grain from the western end of Lake Superior to the seaboard is shown graphically. It will be seen that while very little grain is carried all-rail eastward from Fort William, a large amount is carried by rail from the ports on Georgian Bay to Montreal. Most of the grain, however, goes by water to the eastern end of Lake Erie and there divides into two streams, one turning south to United States ports and the other, considerably smaller, going through the Welland Canal, Lake Ontario and the St. Lawrence to Montreal. No attempt has been made to show on the map the division of traffic between competing trunk-line railways, following various routes between the eastern end of the Lakes and Atlantic seaports, but only the proportions finally delivered at each port.

There is sharp competition for this traffic, not only among the various water and rail transportation lines, but among the several ports. Montreal, Boston and Philadelphia have been particularly active in the development of their port facilities with a view to increasing their proportion of this and other competitive traffic. It is of great interest in connection with this competition to note the investigations by Mr. Evans of the causes for the diversion of Canadian grain to ports south of the international boundary line. The route from the grain-growing districts of Canada to northern Europe via the St. Lawrence is far shorter than the route via United States ports; and yet in 1913 more Canadian wheat was shipped from United States ports than from Canada.

Mr. Evans investigates this problem and finds that the diversion was not due to the physical inability of the Canadian routes to handle more traffic. The St. Lawrence and Welland canals have never carried more than a moderate fraction of the traffic that could be passed through them. Difference in inland freight rates does not explain the diversion. On the whole, Canadian wheat diverted to United States ports appears to have paid higher rates to the seaboard than wheat shipped to Montreal. Mr. Evans then inquires whether conditions of ocean transportation and not the relative facilities of competing seaports or of inland transportation routes are not after all the determining influence that governs the routing of export shipments. He then presents the results of an extended investigation, which indicates that ocean freight rates are the controlling factor in the routing of this traffic.

Ocean Freight Rates Control Inland Traffic

It is commonly supposed that the rate fixed by tramp steamers determines the cost of ocean transportation. This is true on many classes of cheap bulk freight. In the transport of grain, however, the regular liners and not the tramp steamers fix the rate. A liner secures its chief revenue from the carriage of passengers and high-class merchandise. Whatever space it has left available it will fill with grain at whatever freight rate it can get. The amount of grain exported from Montreal in 1913 appears to have been substantially that which the regular liners at that port had room for. Any grain in excess of that capacity had to be diverted to other ports for shipment. The amount of grain carried by tramps from Montreal was very small.

Here is the probable explanation, also, why New York still holds first place among United States ports in the export-grain traffic, notwithstanding the well-known heavy expense involved in handling grain there. New York, because of its enormous trade in high-class imports, has a far larger number of regular steamer lines running to it than any other American port. These liners are willing to take wheat and other grain at a very low rate in order to fill up surplus cargo space. This will doubtless continue to be the case no matter what superior port facilities may be provided at other Atlantic ports.

The bearing of this investigation on the Georgian Bay canal project is obvious. If ocean transportation and not inland transportation is the governing factor in the competition among Atlantic seaports, then Canada might build the Georgian Bay canal and gain no benefit whatever in the restoration of grain traffic to Canadian routes.

Other Benefits of a Deep Waterway

On the other hand, there are possibilities not touched upon by Mr. Evans in the through shipment of grain from Lake ports to Europe without transshipment at the seaboard, if a deep waterway were available. The engineers who have made investigations of deep waterways from the Lakes to the seaboard have hitherto assumed that the Lake vessels were unfit for ocean service and hence that if a deep waterway were built by which Lake vessels could reach a seaport, transfer of their cargo would have to be made there.

Conditions have materially changed, however, in the past 20 years. The Lake steamers have attained an average tonnage much exceeding that of the average ocean freight steamer. The cost of transshipping has been increasing. Again, the war conditions of the past two years have produced unprecedented conditions in ocean traffic. Had it been possible during the past two winters for the shipping of the Great Lakes to have engaged in ocean freight carrying, instead of remaining idle during the winter months, the vessels would have earned enough, in all probability, to have paid the entire cost of a ship canal from the Lakes to the Atlantic.

Field and Office

Engineer talks on night work—Crude diving helmets that worked and are still working—Old well relined with precast rings—Home-made pile hammer replaced steam hammers—Expansion joints placed only when concrete-road work stopped for 30 minutes—Sheetpile coffer-dam driven as unit by use of templet—Hair is pumped without difficulty

Cost of Night and Day Work

By A. M. Shaw*

It will be generally conceded that all construction work can be carried through more economically under favorable light conditions than when only an indifferent light is available. Special conditions may exist—such as those mentioned in the *Engineering News* editorial of Aug. 27—under which heavy traffic or the weather may be a deciding factor; but ordinarily the contractor or the engineer is not called on to decide as to which is to be preferred, day or night work, but the question is: "Will it pay to run both a day and a night crew?"

Judged solely by the net cost of operation, it is not usually economical to do night work on jobs that require a relatively large amount of hand labor. This is especially true on work of a varied nature, scattered over a considerable area and not provided with an ample supply of artificial light. Such conditions entail inefficient work, poor supervision and often are the cause of numerous injuries to employees. The urgency of the case frequently demands that night work be done under these unfavorable conditions, an example of which may be found in the repairs following railroad wrecks and washouts. On such jobs every recurrence presents a new set of conditions; the lighting is usually poor and the men frequently are unfamiliar with the duties required of them. Night work is undertaken most advantageously under a combination of the following conditions:

1. When a considerable proportion of the cost of the job is represented by overhead expenses, such as interest on the investment, insurance, office force, etc., which items are little affected (if at all) by increasing the working force so as to work at night.

2. When the nature and location of the work make it practicable to provide an ample supply of artificial light at small expense.

3. When a relatively small number of men is employed, and these men perform routine duties with which they are familiar.

In the field of earth-handling contracts the two extreme conditions may be illustrated by team-and-scraper work, which can seldom be handled to advantage at night, and the operation of a large modern dredging plant constructing a canal and wasting the earth at the sides of the canal. In the former case, proper illumination at a reasonable cost is impracticable, and both men and animals work at a greater disadvantage at night. In the case of the dredge, practically all the conditions enumerated as being favorable to night work are found. We have here a heavy investment in equipment, a small crew engaged in work with which they become familiar, and it is practicable to provide a liberal amount of artificial light at small expense.

Another advantage is the saving in fuel resulting from the practically continuous operation of a steam plant. Under single-crew operation a considerable amount of fuel is lost in firing up each day and in laying by at night. This saving in fuel and the saving in night watchmen may easily more than offset the cost of furnishing light and even cover the possible reduction in efficiency due to night work.

Siesta Better Than Night Work in the Tropics

It is doubtful if any permanent gain is made by working men at night rather than in the day time on account of hot weather. A better plan would be to follow the Mexican custom and provide for a siesta during the hottest part of the day, say from twelve to three o'clock. On jobs not requiring continuous operation this may often be done to good advantage. This custom is also common on sugar plantations. Laborers employed in construction camps are more adaptable to such a change of hours than those living at home, as the latter class do not take kindly to a change that breaks in on their accustomed hours for rest and recreation. By working men all night the natural order is upset, and in very hot weather they seldom get a proper amount of restful sleep in the day. A visit to the homes of city laboring men discloses the fact that if they work at night, they are compelled to seek their rest in hot, stuffy rooms, often with a horde of children romping about and with interruptions from the usual day noises, making normal, refreshing sleep impossible for the average man. Even in large camps equipped with a special view to the comfort of the men who sleep during the day the rest secured in very hot weather cannot be compared to that obtained in the comparatively cooler nights. Men working continuously at night in hot weather will usually be found to be lacking in energy and initiative.

A good plan of handling double crews is to have them alternate weekly, making the change on Sunday. On dredging jobs a considerable amount of Sunday work is necessary. This is done by the Saturday-night crew, making their "long shift" about 16 hr. On the following week they are let off on Saturday night and do not come back to duty until Monday night.

Repairing What the Night Crew Breaks

On a land-excavator job on which the writer was engaged a number of years ago it was practicable to operate the machine with a crew of only two men, an additional ground force being required to lay track, bring up fuel, etc. This outfit was operated on double shift. Sufficient track material was provided so that the day men could lay up track for the night crew. One of the crews expressed a preference for night work, so this crew

*Consulting Engineer, Hibernia Buildings, New Orleans, La.

was not alternated. It soon became apparent that the output of the night crew was consistently in excess of that of the day men. An explanation was requested of the day operator, which was promptly given as follows: "It takes us half a day to fix up the things that the other fellows bust." An investigation proved this to be substantially correct. Owing to the nature of the equipment it was impracticable to keep up a proper system of inspection and repairs during the night, and the night work was discontinued.

The placing of lights so as to avoid objectionable shadows deserves more careful thought than is given to it on the average construction job. Men cannot work to advantage in semi-darkness or where bewildering and moving shadows interfere with a proper view of their work.

Electric lighting is not always feasible, but is usually preferred when practicable. On many construction jobs independent lighting plants may be installed to advantage, if current is not available from local sources. If a steam supply is not available, internal-combustion engines may be used for driving the generator. Owing to the present high price of gasoline, engines equipped to operate on a low grade of kerosene are preferred to gasoline engines, and they are now made so that they will operate for hours with very little attention.

Electric-lighting outfits may be transferred from one job to another with practically no loss in material and equipment, beyond a small amount of wire that may be wasted in making the change. So far as practicable, lights should be stationary and protected from the weather and from unnecessary vibration. Carbon lamps should be employed only when absolutely demanded by the character of the service, the higher-efficiency lamps being used wherever it is possible to give them protection from excessive vibration.

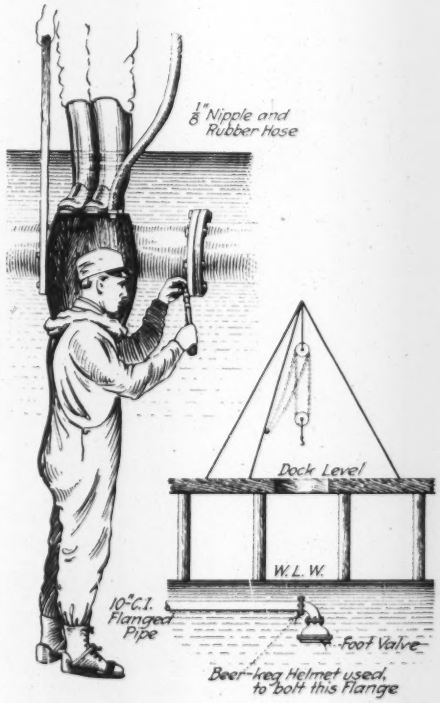


FIG. 1. DETAILS OF THE BEER-KEG HELMET AND THE WORK IT DID

Beer Keg and Kitchen Boiler Serve as Diving Helmets

Two remarkable home-made diving helmets were used in emergency underwater work by J. J. Grafflin, Engineer-Superintendent of the New York Dock Co., foot of Montague St., Brooklyn, N. Y. Fig. 1 shows the first of these and explains the work on which it was employed.

It was necessary under one of the wharves to connect up a 10-in. fire line—under water and in a limited time. It was impossible to do this from the wharf or from a boat, and a diving helmet was not available. A satisfactory helmet was obtained, however, by knocking one head from an empty beer keg. To steady the keg when submerged, a man stood on top, holding to a strip of wood that was nailed to the keg. With this extremely rough outfit it was possible for a man to stay down 1½ min., using only the air imprisoned in the keg. The pipe was bolted to the elbow successfully.

For later work on this same fire line a ⅛-in. brass nipple was fitted into the head of the keg, and to this was attached a rubber tube, through which air was forced by means of a common foot pump. With this arrangement—which was used only in shallow water—a man could stay down about 8 min.

Fig. 2 shows the next step in home-made diving helmets instituted by Mr. Grafflin. This arrangement is one end of an ordinary kitchen boiler notched to fit the shoulders and weighted with chain, as shown. With this rig and an ordinary duplex automobile pump it was

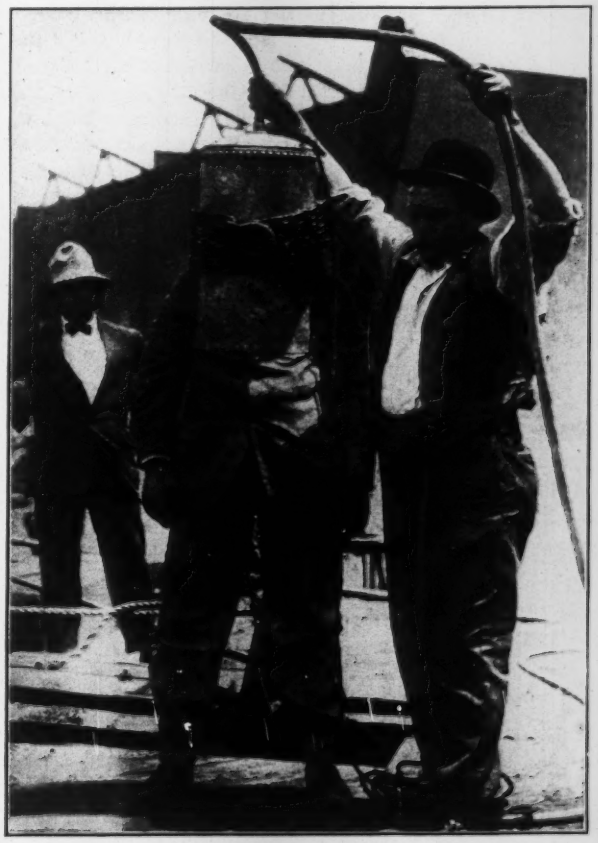
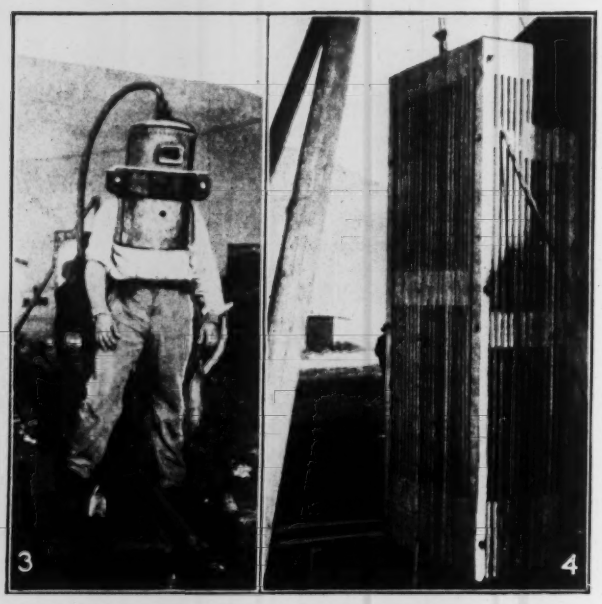


FIG. 2. DIVING HELMET MADE FROM A KITCHEN BOILER



FIGS. 3 AND 4. IMPROVED "BOILER" HELMET USED TO INSTALL PUMP-INTAKE SCREEN SHOWN

possible to stay down 15 min. at a depth of 30 ft. The contrivance was used in the summer of 1914 to clear out in front of the intake to a 1,500-gal. per min. centrifugal fire pump located at the New York Dock Co.'s German-American stores.

In this outfit, as in the case of the keg, there was no window. This omission was not an item of importance, inasmuch as the sense of sight is of no service under the East River. Diving work there must ordinarily be done in the dark. As a general convenience, however, the boiler helmet was ultimately provided with a window, which was merely an oblong glass paperweight cemented to a hole cut in the front of the helmet. With the present rig (Fig. 3) and a regular deep-sea pump Mr. Graftlin has stayed down 1½ hr. This helmet was used in the summer of 1915 to excavate about 1½ yd. of silt and rock in 10 ft. of water, in a space not over 3x4 ft. in plan. The excavation was at the intake of the same centrifugal fire pump before mentioned and was to permit the installation of the screen in front of the intake

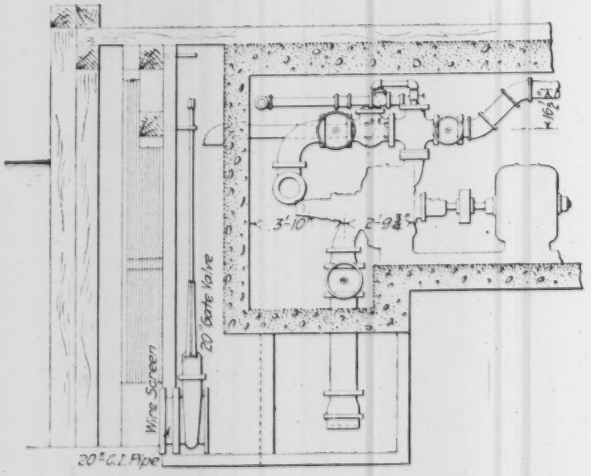


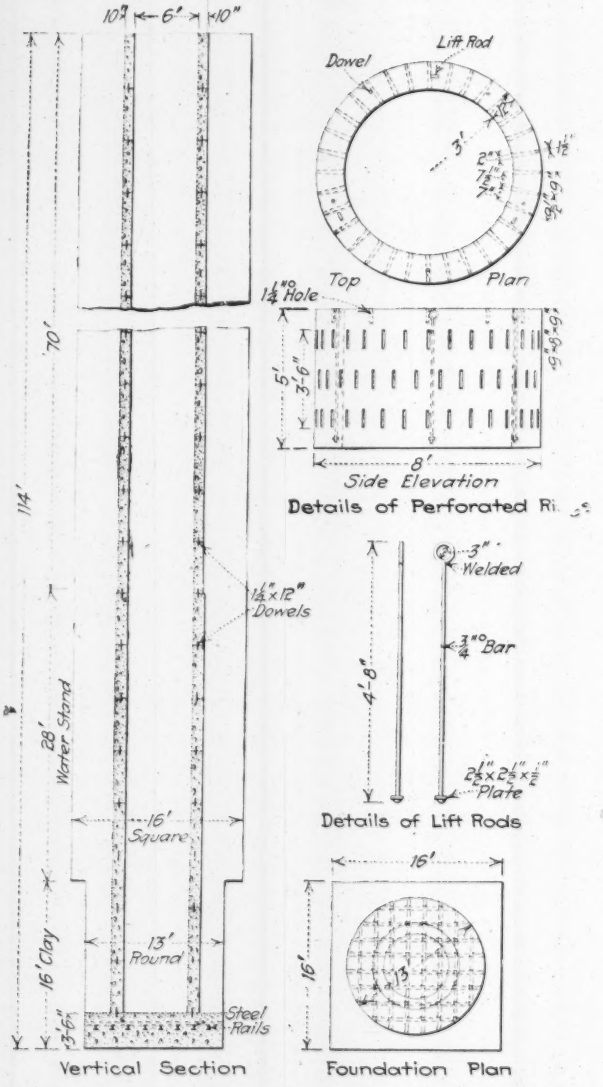
FIG. 5. SHOWING SCREEN IN PLACE AND THE RESTRICTED WORKING QUARTERS

(Fig. 4). Fig. 5 shows the screen in place and indicates the service it performs.

The rough helmet described has the advantage of occupying only about one-half the space of a regular helmet. The sandals were made by the company blacksmith from ¾x4-in. iron. They are provided with a ⅛x1½-in. strap across the toe and tied above the instep with sash cord.

Lining a 114-Ft. Well with Precast Concrete Rings

Following the drought in northwestern Texas in 1909 and 1910, the Fort Worth & Denver City Ry. increased its water-supply at Clarendon by sinking a second well, the first being 100 ft. deep and the new one 114 ft.



A 114-FT. WELL LINING OF PRECAST CONCRETE RINGS

This well was made 16 ft. square and was lined with 8x16-in. timbers. It was in use for about four years, when pumphouse, wellcover and pump suddenly disappeared one morning, leaving only a cone-shaped crater to mark the spot.

As the well was dependable as a water-producer, it was decided to rebuild it. There was no suitable stone

to use for curbing or lining, and it was decided to do the relining with precast concrete rings. A railway derrick car with a 40-ft. boom handling a dump bucket was used to clean out the well, remove the remains of the wooden curbing and place the concrete rings.

These rings were 6 ft. inside diameter, 5 ft. high, 12 in. thick from the bottom to 44 ft. above, and 10 in. thick from there to the top. They were not reinforced.

The mix was 1:3:5, using crushed stone for the coarse aggregate. The concrete was placed by hand in steel forms. After three days, when the forms were removed, the rings were thoroughly wetted three times a day for two weeks. The rings were then allowed to cure for at least two months before use.

Through the water-bearing sand six special rings were used, perforated with three rows of 32 slots each, these slots being 8 in. in length and 1½ in. in width on the outside.

Six 1¼x12-in. dowels at each horizontal joint, set in 1¾x6-in. sockets molded in the rings, took care of lateral movement.

The work of cleaning out the well presented no particular difficulties, except that two pumps had to be kept continuously in operation to keep it unwatered. On the bottom a slab of concrete 3½ ft. thick, reinforced with steel rails, was laid. This was allowed to set for two weeks before building up the well lining on it.

Behind the perforated rings screened crushed rock was placed by hand and well tamped, and above the water-bearing sand earth well puddled was used for backfilling. All of the rings were set without accident, and so far as could be determined by inspection there has been no settlement or displacement of any of them, and the flow of water is fully equal to what it was prior to the cave-in.

A cost table is given herewith. The work was done by the railway company under the supervision of R. C. Gowdy, chief engineer. The steel forms were made in the railway company's shops; the cost of their material is not included, as it was used over.

COST OF CLARENDON WELL LINING

Material:		
70 cu.yd. crushed stone	$45.50	
35 cu.yd. sand	35.00	
440 sacks cement	189.60	
92 lift rods	23.90	
210 pieces pipe, 2x12 in.	17.40	
20 wood blocks, 2 ft. by 12x12 in.	9.04	
105 pieces round iron, 1¼x12 in.	5.56	
		$326.00
Labor:		
Building forms; 2 men 12 days each @ $2.75	$66.00	
Filling forms; 1 foreman 10 days @ $3	30.00	
Filling forms; 10 men 10 days each @ $2.75	275.00	
		371.00
Total material and labor		$697.00
Labor setting 23 concrete pipes in well:		
1 foreman 5 days @ $3	$15.00	
10 men 5 days each @ $2.75	137.50	
		152.50
Total labor and material making blocks and placing in well		$849.50

Pile Hammer for Steel Piles

By D. A. Watt*

In the construction of the lock and dam in the Hudson River at Troy, N. Y., recently completed, several thousand steel sheetpiles were driven in the coffer-dams. Steam hammers were employed almost entirely, as they could be used from a derrick boom and thus reach places inaccessible to the ordinary fixed-lead piledriver. However, their constant breakdowns caused much expense and delay, and in addition they lacked the driving power of a drop hammer. Piles driven on adjacent work with a drop hammer went down deep in heavy gravel 1/4 in. at a blow, while those driven a few feet away with a steam hammer would come to absolute refusal at a considerably less depth of penetration.

In an attempt to remedy these defects a home-made drop hammer was devised by E. C. Quinlivan, Shop Superintendent. It consisted of steel bars bent as shown in Fig. 1 and having a total weight of about 1,500 lb. The bars straddled the pile and were raised by a single line, from a derrick boom, the legs of the hammer moving on each side of the pile, acting as leads and guiding the blow. The anvil (Fig. 2) was made of a piece of steel pile, surmounted by a steel block that received the direct blow and riveted to two channel irons that kept the anvil from falling off the pile and at the same time acted as guides for the legs of the hammer.

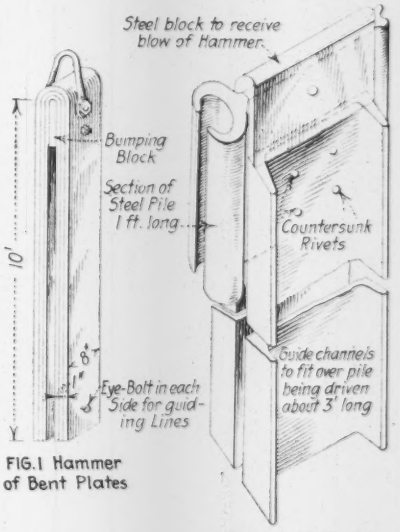

Steel block to receive blow of Hammer.
Bumping Block
Section of Steel Pile 1 ft. long
Countersunk Rivets
10'
8"
1"
Eye-Bolt in each Side for guiding Lines
Guide channels to fit over pile being driven about 3' long

FIG. 1 Hammer of Bent Plates

FIG. 2 Anvil Block

HAMMER AND ANVIL USED IN DRIVING SHEETPILES

As the design was not worked out until toward the end of the construction it was tested only to a limited extent, but as far as used proved very satisfactory. About the only defect in the hammer itself was due to the tendency of the legs to spring gradually apart from the shock of succeeding blows and thus eventually wedge on the anvil. With a cast-steel hammer of suitable design this tendency could be removed. The short piece of pile in the anvil, resting directly on the pile being driven, should preferably be of cast steel with its web not less than 1 in. in thickness, so as to give ample bearing surface.

*Principal Assistant Engineer, United States Engineer Office, Albany, N. Y.

Michigan Omits Joints in Concrete Pavements

By D. A. Thomas*

The revised specifications for concrete roads recently issued by the Michigan State Highway Department provide for expansion joints only at points where the work is stopped for more than 30 min. The clause relating to expansion joints reads as follows:

*Michigan State Highway Department, Lansing, Mich.

Vertical transverse expansion joints shall be placed across the entire width of the concrete roadway perpendicular to the center line where work is stopped for more than 30 min. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to the surface.

Heretofore joints were required at 33-ft. intervals. The value of expansion joints in concrete roads, except at sections where the work is stopped long enough for the cement to acquire its initial set, has often been debated among engineers. It is the belief of the Michigan State Highway Department that, if expansion joints are omitted, cracks will form at approximately the same points at which the joints are customarily placed and that such cracks can then be maintained in the same manner as joints. The early maintenance cost and the construction costs are thereby reduced to no small extent.

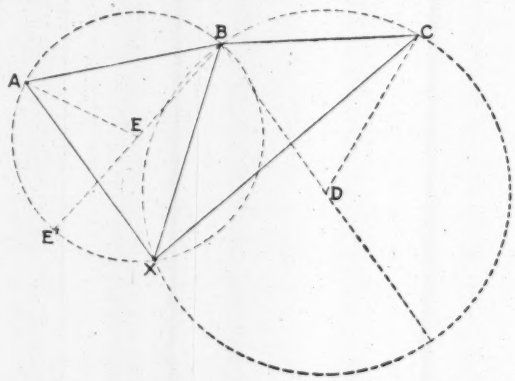
NOTES

A Coffer-Dam Frame, or templet, for holding sheetpiles was used in putting down the coffer-dams for the new Milton (Penn.), bridge of the Philadelphia & Reading Ry. over the Susquehanna River. The templet was moved from one pier location to another along the timber service trestle, as shown in Fig. 1. The coffer-dams were 20x40 ft. in plan. The piling was 38 ft. long, penetrating to rock through about 10 ft. of

TEMPLET FOR SHEETPILE COFFER-DAM, MILTON, PENN.

sand. In accordance with the best practice at the present time, F. P. Kemon set up all the 94 piles of a coffer-dam before driving any. The No. 3 Union sheetpile hammer was swung around the piling, on the end of a crane arm, so that the coffer-dam was driven as a whole.

Simple Geometrical Solution of Three-Point Problem—The following method of solving the three-point problem does not seem to be given in any of the textbooks, yet a simpler graphical solution would be hard to find. The rule may be stated thus: Connect the known points A, B and C by straight lines. At each two points lay off from the line connecting them the complement of the measured angle between the points from the unknown point. Continue each pair of lines to their intersection. Check by noting that the two lines of each pair must be of equal length. The two intersections are the centers of two circles each passing through two of the known points and intersecting at the required or unknown point. In plotting transit notes the rule is literally followed by use of straight-edge, triangle and compass. The geometrical proof can be seen from the accompanying figure at a glance: ABE + AXB = ½ arc BAE' = 90°. With the plane table the method is fully as simple: First, erect perpendiculars at A and B, and B and C, respectively. With the table set at X, set the alidade on A; with its straight-edge lying along the perpendicular erected at A, orient on signal B; clamp the table, swing the straight-edge so as to sight on signal A, and draw AE. This reproduces from the perpendicular at A the



angle AXB and therefore its supplement EAB. In a similar manner BE, BD and CD are obtained and the centers of the two circles E and D graphically determined. Their intersection is the required station of the plane table.—H. K. Higgins, Jackson, Mich.

A 40,000-Gal. Steel Flour Bag on the top of a steel tower contains the water necessary for the operation of an automatic-sprinkler system recently installed at the Campbell Flour Mills Co., Ltd., Toronto. The top of the tank is 152 ft. above ground. The tank is 37 ft. deep by 18 ft. wide and has an oval cross-section. The Chicago Bridge and Iron Works built the tank.

Pumping Hair is done by a No. 2 Nye steam pump at the plant of the Wilder-Manning Tanning Co., Waukegan, Ill. The pump is located between two hidescraping machines that take all the hair off the hides. The hair is washed down by small jets of water to a sloping runway at the back of the scrapers, and down this runway to the pump sump. The mixture is pumped vertically about 30 ft. and horizontally along under the second floor about 100 ft., where it is discharged into a washer and later dried and baled. The pump replaced an elevating conveyor that is said to have had a tendency toward freezing up in the cold months. Another pump of this type will shortly be installed here.

A Culvert Intended To Be Overflowed during times of extreme high water is shown in the accompanying view. This culvert is on the Shelbyville turnpike between Shelbyville and Wartrace in Bedford County, Tennessee. The waterway consists of 10 semicircular arches of 36-in. span. The crown

OVERFLOW CULVERT ACROSS BUTLERS CREEK

thickness of the arches is 5 in. of plain concrete. The whole structure is 60 ft. long, 14 ft. wide and cost $175. When the culvert and pavement are submerged, wires are strung along one side so that the traveler will have little difficulty in "following the trail." This culvert was designed and built by C. L. Shoffner, general manager of the Shelbyville turnpike. It is obviously a variation of the arroyo crossings of the arid West, described in "Engineering News," Sept. 14, 1916.

Editorials

Selection and Use of Cars for Construction Work

The review of various types of cars used in construction and improvement work, which is given elsewhere in this issue, suggests a consideration of the classes of work for which different types of cars are adapted.

The selection of equipment for any one piece of work will depend largely upon the local conditions and upon the equipment already owned by the contractor, railway or other party doing the work. Among the local conditions to be taken into account will be the general character of the work; whether the work is convenient to or distant from railway or other means of communication; whether cuts and fills are heavy or light; the kind and total quantity of material to be handled; the length of haul, duration of work, etc. For work that is difficult of access the cars must be of such size and weight as to admit of being transported to the site by wagons or other means.

In selecting equipment for railway work to be done by company force, the question may be whether to buy cars that can be used in work-train service only or those that can be assigned to ordinary freight service in winter or at other times when not required on construction. Cars of the latter class offer advantages in the fact that they may be kept practically in continual use instead of lying idle at times. On the other hand, they might be needed in both kinds of service at the same time, and the car suitable for one kind of service might be less suitable (and less economical) for service of another kind.

Where a railway has extensive and costly construction or improvement work to be done, it will often be both advantageous and economical for the engineering or construction department to have its own equipment and not be required to rely upon some other department for its supply. Narrow-gage construction equipment is rarely owned by railways, as it is of special class and its use is of restricted availability. Such cars are frequently found, however, in railway contract work and are of particular service in widening roadbed and cuts, where they can be operated very often without interfering with running tracks and regular traffic. In this way the occupation of main track by work trains may be avoided.

It must be borne in mind that it is not always advisable or even possible to adopt the equipment that theoretically is best suited to the work and conditions of a particular job. Both contractors and railway departments are compelled sometimes to work under conditions not favorable to the lowest cost, because they have to use equipment which is in hand, and they cannot—or do not wish to—invest capital in additional equipment that might not be of much service for future work.

This is true especially of jobs of the smaller class. On a large piece of work (contract or otherwise) it is not advisable or economical to attempt to carry it on with insufficient equipment; but even here the use of such equipment may be obligatory. Thus expediency and arbitrary limitations are often important factors in the selection of equipment.

There is another side to this investment phase of the question, however, and that is the possibility of leasing or renting cars. Under such an arrangement the contractor or other user can obtain the equipment best suited to the work without the possible objection of having it idle on his hands later, on account of its being unsuitable for other jobs. The leasing plan is adopted by a number of firms that build or supply cars, and it covers practically every class of car for construction work.

An important point in relation to the efficient and economical operation of the cars is the maintenance of the temporary or construction tracks in good running condition. This need is not always recognized, and men in charge are apt to assume that almost any kind of track is good enough for dump-car trains. But the weight of train hauled and the efficient progress of the work are affected materially by track conditions. Derailments also are likely to be frequent on poor track, and these cause delay and interruption, extra repairs, etc., or perhaps the loss of a load of concrete. All these adverse conditions are reflected in an increased total cost of work.

Good track, substantially built and well maintained, is highly desirable for economic reasons. It may increase the hauling capacity, enable trains to be run safely at higher speed, reduce delay and expense due to derailments, minimize various other troubles and thus facilitate the progress of the work and tend to reduce its cost. The importance of good construction track increases rapidly with the weight and capacity of the cars employed. The object of using large cars is to reduce unit cost by speed and economy in handling material, and this cannot be attained where trains are stalled and cars are derailed frequently.

A corollary to the proposition of good track maintenance is the proposition of keeping the cars in proper repair and good running condition. Delays in transportation and dumping due to bad-order cars are quite as serious as those due to track in poor condition. These are matters for the special attention and watchfulness of the engineer or superintendent in charge of construction work.

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Effect of Heat on Rate of Flow of Fluids

The paper by W. L. Butcher, published in *Engineering News* of Aug. 17, reviewing experiments which indicate that the rate of flow of water is materially increased by rising temperature, has brought us several letters from correspondents who appreciate the importance of this matter. It has, of course, long been well known that the heating of oils has a great effect on their viscosity and consequent rate of flow. Many engineers, from practical experience with automobile carburetors, have become familiar with the very great influence a change in temperature has upon the rate of flow of gasoline through the

narrow passage of a carburetor nozzle. It is reasonable to believe that if a liquid which has so little apparent viscosity as gasoline will nevertheless have its rate of flow materially affected by heat, then the same thing may be true of water.

The limited amount of data which Mr. Butcher was able to unearth in technical literature indicates that this may be the case; but as various correspondents point out, there ought to be available for the use of engineers accurate and complete information and data showing what corrections should be used in computations for the flow of liquid where large variations in temperature are involved.

There would seem to be an opportunity here for useful work by post-graduate students in some of the engineering schools which have suitable hydraulic laboratory facilities. Possibly the Bureau of Standards might take the matter up, although we believe the work of original investigation already accumulated by that bureau is sufficient to keep it busy for a long time to come.

It may be worth while inquiring, too, whether any similar effect occurs in the flow of gases. The present formulas for the flow of gases take into account, of course, variations in flow due to the change in volume of the gas as a result of heating. It is quite possible that there may be some variation in the internal friction of a gas due to its heating corresponding to what takes place in the case of liquids. If so, it should be possible to discover this by accurate experiments and apply suitable corrections in the formulas.

Mechanical Engineers Society Pays Off Its Debt

In a bulletin just issued to the membership, the officers of the American Society of Mechanical Engineers state that the last of the bonds issued by the society to finance its part of the Engineering Societies' Building enterprise were paid off on July 1, and the society is now out of debt. Many will recall that when, a dozen years ago, Andrew Carnegie electrified the engineering profession with his generous offer of $1,500,000 to erect a great building in New York City as a home for the national engineering societies, he coupled with it the stipulation that the societies themselves should purchase the land on which the building was to be erected.

The cost of this land was about $540,000, and this investment in itself seemed to many a large burden to be assumed by the three societies that accepted the offer. The immediate financing was made easy, however, by Mr. Carnegie, who advanced the money for the land purchase. For a number of years this loan was continued, the societies paying interest upon it. Each of the societies made energetic efforts to raise the money to pay off this debt by circulating subscription papers. It was hardly to be expected, however, that so large a sum would be raised by direct subscription, and there was a general opinion that the societies themselves should bear the burden. Principally through the efforts of the late Charles Wallace Hunt, who was for many years active in the council of the American Society of Mechanical Engineers, a plan was devised by which the money was raised to pay off the balance of the debt for the land in the following manner: The society issued interest-bearing bonds equal in face value to the amount of the debt, announced that the portion of its income derived from initiation fees would be segregated each year to pay off an installment of these bonds and invited subscriptions from the members of the society. The sum desired was promptly secured and, as announced above, the last of these bonds has now been paid off.

Another announcement in the bulletin issued to the society members is of general interest. There is a more or less general impression among the members of the national engineering societies that a large part of the money they pay in for their annual dues is expended in maintaining the expensive offices and headquarters in the big building in New York City.

To those who may have held such an opinion, it will be of interest to note the statement issued by Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, that at the present time less than 5% of that society's annual income from dues is absorbed in paying its share of maintaining the building in New York City. If the society owned no property whatever and merely rented the space absolutely necessary for the clerical force required to carry on its work at its headquarters, in New York or any other large city, the annual rental would amount to more than 5% of its income from dues.

Recovering Steel Sheetpiling

Steel sheetpiling is worth recovering because unlike most second-hand steel it can be used repeatedly. A few years ago the feeling was quite general that steel sheetpiling—even though driven in structures of temporary service only—was a dead loss and therefore expensive and of an emergency nature. Since then a number of schemes have been devised for recovering the piles economically, and it is now unusual not to attempt, at least, to recover piling used in temporary structures such as coffer-dams.

About two years ago a machine designed especially for pulling piling was developed in England and was described in *Engineering News* of June 11, 1914. This machine was practically an inverted steam hammer. Since, ordinary steam hammers have been used inverted, one manufacturer making a special point of this. This method has been successful in many cases and is now a matter of general knowledge and fairly extensive experience. A large and successful operation of this kind was the pulling of the coffer-dam construction for the land connection of the Harlem River crossing of the new Lexington Ave. subway, New York City. The extractor consisted of an ordinary steam hammer with a few minor additions suggested by the contractor's superintendent. According to the latter, this tool pulled piles which three derricks working together were unable to budge. The inverted hammer weighed 1,500 lb. and withdrew piles that had been put down by a 5,000-lb. hammer. This same scheme has been tried—but not with remarkable success—in pulling the piling for the coffer-dams used in building the municipal piers at 47th St. in the North River, New York City. This is an extremely difficult job and other methods than the inverted hammer have proved inadequate on it.

Hydraulic jacks have been used in several instances with more or less success. One of the first instances of this kind was at one of the shafts of the Newark Bay tunnel of the Passaic Valley sewer. Blocking was placed

close against both sides of the piles to be pulled and a 50-ton jack was mounted on each set of blocks. This method was not noted for its speed. A crew of five men and a foreman sometimes required eight hours to pull one pile. In pulling the sheetpiles from the earth-filled coffer-dam at Troy, N. Y. (*Engineering News* of Aug. 31), 150-ton hydraulic jacks were employed. To jack out a key-pile required one to two days. An inverted steam hammer was tried here, but breakages were excessive and the method was not certain.

A novel expedient was tried recently in recovering a large tonnage of 60-ft. steel sheetpiling driven in the form of a series of arcs. A combination of water and air jets was used to loosen the material about the pile to be pulled. The method was eminently successful.

It is evident from the foregoing that a number of methods have been developed for recovering sheetpiling. Not only does this indicate that the operation has a tendency to be difficult, but it also shows that the desire to recover this piling is quite general. In view of conditions in the steel market at the present time, steel piling is worth recovering for its scrap value, even though it be not used again in a structural capacity. The method adopted on a specific job is usually dependent not only on the character of the piling—size, penetration, soil, etc.—but also upon the machinery available.

Curbing City and County Debts

New Jersey has come to the front with a notable act governing municipal and county debts. The act establishes a relationship between the life of bonds and the works they are to pay for and limits bonded debt in proportion to the assessed valuation of real property. The first is a new departure in the United States, so far as we are aware, and both features of the act are not only worked out logically but means are provided to see that they are enforced.

There has been no lack heretofore of limitations on the life of bond issues, but the limits have been arbitrary and have meant but little. Moreover, there has been too often no adequate provision to make certain the redemption of the bonds at maturity, although of late there has been a strong and commendable tendency to pay off bond issues in installments instead of relying on that threat against sound municipal finance, a poorly guarded sinking fund.

The New Jersey act of 1916, abstracted elsewhere in this issue, compels city and county officials to face two questions whenever a bond issue is authorized and to write the answers boldly in the bond ordinance. The first question is, How long may these proposed works be expected to perform useful service? The second question is, What will be the net debt of the city if these bonds are issued? More wholesome questions could not be pressed home whenever an increase in the municipal debt is contemplated.

Not content with forcing city and county fathers to ask themselves what the life of the proposed works will be, the New Jersey act sets limits beyond which too sanguine authorities cannot go. In like manner it fixes a municipal debt limit and tells how it must be computed. The particular limit set on the life of the bonds or on the amount of net debt a city, town or county may incur may or may not be wise. The main point is that two cardinal principles in sound public finance have not only been recognized, but that a well-considered law to put them in force has been worked out in considerable detail and placed on the statute books of an American commonwealth.

Fortunately, these sound principles of public finance can be widely adopted in other states without specific legislation. Hundreds of cities are free to make the life of their bonds come within the probable life of the works for which they are to pay; the majority can perhaps choose serial bonds in place of sinking funds; few if any can be forced against their judgment and will to pile up municipal debts faster than sound municipal finance warrants.

But while any municipality may go far along these lines if it desires to do so, many will make no move in that direction unless compelled. Engineers should therefore use voice and pen to create both local and state public opinion against piling bond issue on bond issue for public works worn out before the first bonds are redeemed and public debts out of proportion to financial resources.

British Engineers in Canada

The following remarks appeared in the London "Surveyor" of Aug. 25, 1916, under the heading "The Outlook for British Engineers in Canada":

> Is it not possible that when the Great Crisis is over many of our returned engineers may look to Canada as a fertile field for the exercise of their professional skill? If so, our advice to them would be, emphatically, Don't! We have it on excellent authority that most of the towns and cities there have spent so much in the past, and the war has caused such a great setback, that it will take a long time for them to revive the stage when the services of consulting engineers will be needed frequently. Moreover, practically all the plums in this line are given to American engineers. For many reasons there is a strong tendency to select them, while the next choice falls to Canadian-born engineers. It is generally held that American methods and ideas are best suited for Canada, and no doubt this belief is sedulously fostered by interested Americans. Anyhow, men from the Old Country are not encouraged, and it is well this should be put plainly.

It may be well to warn British engineers not to look to Canada as a field for employment; but the reasons might have been more accurately stated. Although some of the cities in Western Canada went too fast and far in municipal expenditure and particularly in real estate booming before the War, and while all of them have been sacrificing men and money and curtailing municipal and other civil expenditures during the War, it is probable that Canadian municipalities as a whole will resume the construction of public improvements on a large scale soon after the War ends. By far the larger part of the engineering work involved will naturally and properly be done by Canadian engineers. These men are destined to harvest most of the plums—and the lemons also. A few consulting engagements will doubtless come to engineers in the United States, but our British contemporary is far afield in its supposition that all the best engagements and large fees go across the international boundary.

What is more natural than that engineers of Canada and of the United States should be given preference over those of Great Britain, when the first are on the spot where the work is to be done; the second are next at hand while the third are a long ocean journey away?

As to it being "generally held that American methods and ideas are best suited for Canada," this is so obviously in accord with the facts as to leave no need whatever that the "belief" should be "sedulously fostered by interested Americans."

Letters to the Editor

Careful Design Needed for Wall-Bearing Flat Slabs

Sir—The report on the "Flat-Slab Floor Failure Due to Poor Brick Wall Columns," appearing in your issue of Aug. 10, 1916, should do much toward the abolition and suppression of the criminal practice of designing flat-slab floors resting on exterior brick piers in practically the same manner as if they were carried on reinforced-concrete columns capable of taking the bending moment induced in them by the eccentric application of the loads. Some engineers have become so enthusiastic over flat-slab construction that they seem to think it will do the impossible. That any designer can so lose himself in the mathematics of the problem as to ignore the broad principles of commonsense is almost beyond comprehension. Picture a building three bays wide, having spans of 22x20 ft. 3 in. with reinforced "pipe-stems" 12x12 in. in cross-section forming the interior supports of a flat-slab roof resting on exterior brick piers 13 in. thick. Such was the shop building of the Boys' Industrial School at Roxbury, Mass. If that can be called "good practice," then the work of our various joint committees, engineering societies and city building departments has been an utter waste.

It is now generally conceded by designers that, owing to the monolithic nature of the construction, bending moments of considerable magnitude may be induced in the exterior columns and those adjacent to the exterior by unequal distribution of loads. That a 12x12-in. column reinforced with four 7/8-in. rods is good for a relatively small moment, and much less so a brick pier 12 or 13 in. thick, can be readily appreciated by an engineer without much computing. The direct load on the column may warrant the use of one very small cross-section, which when investigated for its resistance to bending may be wholly inadequate. Some of the more prominent city building ordinances and rulings on flat-slab design take this into account by specifying minimum sizes of columns or the amount of bending which the columns must resist in addition to the direct load.

The Chicago ruling says: "The least dimension of any concrete column shall be not less than one-twelfth of the panel length, or one-twelfth of the clear height of the column." The Cleveland, Ohio, code limits the diameter of interior, spirally reinforced columns to one-thirteenth of the span for floors and one-fourteenth for roofs. An exterior column supporting a roof the Philadelphia code requires to be figured as taking 80% of the negative moment developed in the roof slab at the edge of the column head, and other wall columns as taking 40% of the negative moment developed at the edge of the column head, above and below the floor considered.

The interior roof columns in the building in question had dimensions of one-twenty-first of the average span, while to conform with the Chicago code, instead of being 12 in. square they would have been 21 in. square, an increase in section which no doubt would have enabled them to resist the additional moments coming upon them, due to the inability of the brick piers to take bending, and possibly might have avoided the failure. The framers of the codes mentioned are to be commended on placing limitations on the minimum sizes of concrete columns allowable in flat-slab buildings, based on the span of slab as well as the unsupported length of column. Such failures as the one in question, demonstrate the absolute need of such requirements. The largest columns in the Roxbury building were only 18 in. square, which was smaller by several inches than the minimum or top-story column should have been. Combined with the uncertain action of brick piers as exterior supports, the results are not at all surprising.

For the best interests of all concerned and for the advancement of good construction, flat-slab floors with brick walls as exterior supports should be absolutely prohibited by law, unless designed in accordance with the most conservative assumptions as to spans and moments, and the bearing walls stiffened by projecting pilasters or piers at frequent intervals, preferably to line up with interior columns, which should have a sufficient cross-section to withstand bending moments induced in them by unbalanced loadings on slabs. ALBERT M. WOLF.

Chicago, Ill., Aug. 14, 1916.

Sir—Sanford E. Thompson is quoted, in your article on the Boys' Industrial School at Roxbury, as having stated, "My criticism of the design relates chiefly to the improper combination of the reinforced-concrete flat slab with the brick walls. This combination is a poor construction at best." With this statement of Mr. Thompson's we thoroughly agree. By tests, deflection measurements, theoretical analyses, and practical experience, during the last few years, it has been proved beyond doubt that the combination of brick wall bearings and any reinforced-concrete construction depending upon continuous action in its members is not to be considered as good engineering practice.

Even provided that the walls and wall piers are built of first grade material, and that first-class workmanship is applied, a difference in the settlement of the walls as compared to the settlement of the construction at the best. In fact, we would consider it as an impossible construction from the viewpoint of good engineering practice. Even provided that the walls and wall piers are built of first grade material, and that first-class workmanship is applied, a difference in the settlement of the walls as compared to the settlement of the interior columns can hardly be avoided, and it is a well known fact that uneven settlement of these supports generates very excessive moments over the interior columns, and also negative moments in the center portion of the interior panels. Although the positive moment in the exterior panels may be designed with the assumption of a free support on the walls, the elastic deformation in the slab will cause a negative moment of some

magnitude in the walls, since no provision can be made, from a practical standpoint, for hinges at the wall support. The eccentric conditions of loading thus generated in the walls will cause an increase in the compressive stresses, and, possibly, tensile stresses over a part of the wall section, which stresses are more safely taken care of by reinforced-concrete wall columns. From a viewpoint of economy also, we have found, in our experience, that a combination of wall columns, lintels and curtain walls is more advisable than bearing walls and piers, when the latter are designed and constructed at their best.

In addition to the apparent carelessness in the design and construction of the exterior walls, it seems to us that, according to the information given in the article, the methods of choosing the dimensions of the other structural members were just as hazardous.

From the column schedule we learn that the interior columns in the higher portion of the building are 12 in. square, reinforced with four ⅞-in. round rods. It is a rigidly enforced law, required by most of the well known building ordinances, that the smallest diameter of the column shall not be less than $\frac{1}{12}$ of the clear span of the slab, for flat-slab construction, and not less than $\frac{1}{12}$ of the clear story height for any reinforced-concrete construction. This minimum is entirely justified from the viewpoint of good engineering practice, since an unbalanced distribution of loads, or an excessive ratio of slenderness, is apt to cause bending stresses in the columns. It is true that the bending moments in the columns will be reduced, due to the fact that the columns are restrained vertically by the columns above and below, and laterally by the adjoining slabs, thus forming a rigid frame with the adjacent panels as well as the stories above and beneath. No matter how small this moment may be, however, it is there just the same, and the conscientious designer will take it into consideration. This building would require columns at least 21 in. in diameter, with a gross sectional area of 346.4 sq.in.

With respect to direct load, we find that the columns used in the building are barely able to withstand the superimposed dead-load. Considering the relative large importance of a column, a factor of safety of 5 is not too conservative. Moreover, it is a generally accepted rule not to use the fireproofing portion of a column for the direct load. Using these principles as a basis, the allowable safe unit stresses for a mixture of 1:2:4 concrete would be 400 lb. per sq.in.; for a mixture of 1:1½:3, 480 lb. per sq.in. on the net sectional area of the columns, using an n of 15 and of 12 respectively, for the allowable safe unit stresses in the vertical reinforcing steel. Refiguring, on this basis, the total loads which the columns are able to withstand, we find, as already stated, that there is no permissible live-load.

Making the unsound assumption of a factor of safety of 3½, for concrete in direct compression, and using the gross area of the column, the largest possible live-load the columns are able to withstand, according to our investigations, would be 25 lb. per sq.ft. on the roof and about 75 lb. per sq.ft. on the first and second floors. We wish to emphasize, however, that this load, considering the bending moments in the columns, would seriously impair the safety of the structure, and we used this basis of design only in order to find the live-load which the man laying out the building might have had in mind while assuming the dimensions.

The same inconsistency with respect to relative strengths appears in the flat-slab designing. Making the most favorable assumption, that all the slab rods are bent up over the columns, thus being effective in the top portion of the slab, we find that the resisting moment over the column would be able to carry safely a uniformly distributed live-load of only 60 lb. per sq.ft. in addition to its dead weight, while the slab at the center of the panel is strong enough to withstand a load of 600 lb., or ten times as much as the other portion. It is one of the fundamental principles of engineering design that each member of a structure shall have a degree of safety in proportion to its relative importance, giving the structure an even strength throughout. Using 100 lb. per sq.ft. live-load as a basis for designing the building, a saving of about 15 to 25% could have been obtained in addition to the 100% of cost due to rebuilding the entire structure.

Failures of this kind do not only reflect upon the responsible party, but upon the entire engineering profession, jeopardizing its reputation and integrity; also discrediting a type of construction and structural material that has proven its merit for many years. The engineering profession *in corpore* should apply strict and energetic methods to prevent repetitions of a similar character, not only for our own sake but primarily for the protection of our clients and for the safety of the general public.

CURT VON MUELLER,
Concrete Steel Products Co.

Chicago, Ill., Aug. 25, 1916.

Opportunities for Civilians To Become Engineer Officers

Sir—It is expected that the next examination of candidates from civil life for appointment as second lieutenants in the Corps of Engineers, U. S. A., will be held on or about Jan. 29, 1917. There will probably be about 30 vacancies, which it is desired to fill from that examination. Candidates to take this examination must be (a) unmarried, (b) between 21 and 29 years of age, (c) graduates of approved technical schools, (d) eligible for appointment as junior engineer in the Engineer Bureau of the War Department.

It is believed that there are a large number of well-qualified young engineers who comply with the conditions (a), (b) and (c) above and who will desire to take this examination. *In order to qualify under item (d) above, it will be necessary for all such young men, who are not already so qualified, to take the Civil Service Commission's examination for junior engineer, civil, to be held at numerous points throughout the country Oct. 11 and 12, 1916.* The Civil Service Commission informs me that the results of the October examination will be determined in ample time to allow the successful candidates to take the War Department examination for second lieutenant on or about Jan. 29, 1917.

Applications from persons along the Atlantic Coast to take the examination Oct. 11 and 12 should be submitted so as to reach the United States Civil Service Commission, Washington, D. C., at the very latest by Oct. 8. For other parts of the country applications must be submitted earlier. In every case applications should be submitted as soon as possible to insure the receipt of the approved

application at the place of examination by Oct. 11. Application blanks may be secured by addressing the Civil Service Commission, Washington, D. C., or by addressing or calling upon the secretary of any of the civil-service districts. These districts with their headquarters are as follows:

First	Boston, Mass.	Post Office Building
Second	New York, N. Y.	Custom House
Third	Philadelphia, Penn.	Post Office Building
Fourth	Washington, D. C.	
Fifth	Atlanta, Ga.	Post Office Building
Sixth	Cincinnati, Ohio	Post Office Building
Seventh	Chicago, Ill.	Post Office Building
Eighth	St. Paul, Minn.	Post Office Building
Ninth	St. Louis, Mo.	Post Office Building
Tenth	New Orleans, La.	Custom House
Eleventh	Seattle, Wash.	Post Office Building
Twelfth	San Francisco, Calif.	Custom House

It may be stated that while the examination papers from the recent examination for second lieutenant, held Aug. 21 to 25 of this year, have not yet been completely marked, a preliminary report received from the board marking the papers shows that several of the candidates will probably receive marks of over 90%, from which it would appear that the examinations are not too difficult for the class of men desired. W. M. BLACK,

Chief of Engineers, U. S. A.

Washington, D. C., Sept. 23, 1916.

Wanted: Contractors

Sir—I find that this state (Kentucky) has not enough road contractors, or contractors who are capable of doing good reinforced-concrete work. I think it would be well for contractors to investigate prospects in Kentucky.

R. WILEY,

State Commissioner of Public Roads.

Frankfort, Ky., Sept. 21, 1916.

Concrete Road Pavements on Sandy Soils

Sir—A piece of road under improvement near here crosses some hills of fine shifting sand, and most of us doubt whether the surfacing will last. The sand gives very poor footing and is considered a treacherous foundation material. Will a concrete slab laid on such sand, without reinforcement, be able to last without cracking and breaking up?

This subject of roads on unreliable sand soils is not thoroughly discussed in the few books available here. The town officials have asked me whether some kind of clay or stone or mixed surfacing, or anything cheaper than a hard pavement, can be used successfully on this sand. Improvement of several roads besides the one mentioned is planned, and they also cross sand stretches in part.

You would do a service if you could give a brief outline of the subject of road construction on bad sand soils, especially in the direction of indicating cheap types of construction for light-weight traffic.

HENRY D. JOHNSON.

——, Long Island, Sept. 7, 1916.

[A member of the editorial staff of *Engineering News* visited the road in question, and he believes that the doubt as to the durability of the concrete pavement under construction is well founded, but not on account of the sandy soil under it.

An adjoining stretch of pavement on the same road, which was completed last season, shows wheel-track ruts and other evidences of very poor concrete, but no evidences of foundation failure. There seems no good reason for believing that a sandy soil makes other than an excellent foundation for concrete pavements.

The road in question does not appear to be a heavily traveled highway, and were clay available a sand-clay surfaced road might have answered. On the other hand, the conditions are almost identical with those on Cape Cod, where the Massachusetts State Highway Commission has been very successful in constructing oiled-sand roads by both the penetration and the mixing methods.—Editor.]

Gravel Cover on Concrete Highway Bridges

Sir—I notice in *Engineering News* of Sept. 7 a communication from C. E. V., Syracuse, N. Y., entitled, "Why Put a Gravel Cover on a Concrete Floor of a Bridge?" While I agree with C. E. V. that the average country bridge is in danger of overloading from this cause, there is a very good reason for carrying the road metal across the bridge floor.

Anyone familiar with road maintenance knows the difficulty of keeping the gravel or macadam up to the level of the bridge floor. The wheels of vehicles coming off the concrete onto the road metal are sure to cause a depression. This depression is not only annoying to autoists, but becomes a source of real danger to traffic. There is but one satisfactory method of avoiding this—namely, carrying the road metal across the bridge so that there will be no break in the road surface.

Decatur, Ind., Sept. 14, 1916. R. L. LONGSHORE.

NOTES AND QUERIES

The Pumping Station at Shrewsbury, Mass., illustrated on p. 433, of the issue of Sept. 7 was designed by E. Worthington, Consulting Engineer, Dedham, Mass. The view shown is the rear of the station.

The Effect of Bichloride of Mercury in a very diluted form on cast-iron pipe or on monolithic concrete is the subject of an inquiry. If anyone has any data on the subject "Engineering News" would be glad to give publicity to them.

The Soil Pressure Test Device, described in "Engineering News," Aug. 24, 1916, was devised by E. B. Smith and A. T. Goldbeck, of the United States Office of Public Roads. Mr. Smith was inadvertently referred to in that note as T. B. Smith.

The Electric-Car Ferry at Oakland, Calif., mentioned in "Engineering News," Sept. 7, is not the first of its kind. The Evansville Railways Co. operates a car ferry across the Ohio River at Evansville, Ind., on its interurban line between Evansville and Henderson, Ky. The boat is a "side-wheeler" 120 ft. long, with each wheel driven by a 50-hp. gasoline engine. This ferry was described and illustrated in "Engineering News," Nov. 21, 1912.

Concrete for Brick-Pavement Base—W. H. W. writes from Pennsylvania:

In laying brick paving is concrete made of slag preferable to concrete made from hard stone? The specifications we are using for brick paving call for a concrete base 6 in. thick, using a good hard rock in the mix. The brick is to be laid on a sand cushion. The question has arisen whether it would not be better to use a slag-concrete base 5 in. thick, with a 1-in. mortar cushion. Recent tests seem to show that in most cases the slag concrete is stronger than the stone.

The variations in test results on different samples of concrete are often so great that figures may seem to show a superiority of concrete made from one material over another when no such superiority exists. It is doubtful whether any change in the aggregate used would justify reducing the thickness of a pavement foundation from 6 in. to 5 in. Regarding the change in the cushion used under the brick, while most brick paving is still laid on a sand cushion, recent practice favors the use of the mortar bed.

Intermittent Excess Coagulant at Springfield, Mass.*

By Elbert E. Lochridge†

Coagulation by sulphate of alumina prior to slow sand filtration has been the practice at the West Parish filter plant of Springfield, Mass., since its construction. Records are now available covering six full years. During the last four years of this time the method of application has been so altered that materially reduced amounts of coagulant are necessary, although at all times it has been possible to produce satisfactory water. This method has been the application of overdoses of sulphate of alumina to the water intermittently. The filters, six in number, are of the slow sand type and of one-half acre area each. The water of Little River as it comes to the filters is that of a mountain stream usually clear, of low alkalinity, but with a varying color, which with the rise of the stream may increase several fold within a few hours. This color in the river water may be low enough for use without any reduction for a long period of time, when suddenly a rise in the stream will cause a large increase of color which makes the water objectionable for use.

The Little River at the point of diversion has a catchment area of 48 sq.mi. The water is diverted from the stream in a deep and narrow gorge and sent through a mile of tunnel to a sedimentation basin eight acres in area with a capacity of 40,900,000 gal., or between three and four days' supply. From this small reservoir the water is drawn to the filters. The water from the tunnel is carried by a concrete conduit to an arm at the greatest distance from the outlet. There are no baffles or other artificial obstructions in this reservoir. The coagulant is applied in solution to the water in transit in the concrete conduit at a point which causes it to travel with the current 540 ft., permitting some mixing before its submerged delivery into the basin. Water is constantly flowing from the river to this basin through the conduit and is drawn uniformly from this basin to the filters.

Determination of Amount of Chemical

The determination of the amount of aluminum sulphate necessary for complete reaction is made in a series of 2-gal. bottles from fifteen to twenty in number, which are filled each day with the river water. To these are added, in uniformly varying increments, definite amounts of sulphate of alumina. Within a few hours all of the bottles with amounts of coagulant in excess of the "reaction point" will indicate complete color removal, and the precipitation of foreign matter will be complete, while all bottles containing less coagulant than this amount will be in a cloudy or murky condition, indicating incomplete reaction. The determination is made in this manner each day, permitting a study of the effects of the rise and fall of the stream, the effect of storms, melting snows, etc. The amount of coagulant actually applied to the water is always a little in excess of the reaction point determined, and during the period of application this is kept as nearly constant as possible.

With the amount or rate of coagulant application per hour thus known, it is still necessary to determine the number of hours per day during which it shall be added. Throughout most of the year from 4 to 6 hr. per day is sufficient, but at a time of flood, resulting in a very material increase in color, this period may be lengthened to 12 hr.

Generally speaking, the standard set for filtered water is that of no coagulation if the color does not exceed 25. Before the filtered water reaches this figure, coagulant is resorted to, and during such application the color is to be kept at 20 or below. Under the old method of constant coagulant use, it was found impossible, especially at times of low alkalinity or sudden changes, to add sufficient sulphate of alumina to reduce the water to a satisfactory color at all times. The addition of soda ash or lime was necessary for restoring alkalinity at such times. This is entirely unnecessary with the intermittent application, as but a small portion of the alkalinity is used in the formation of the floc.

Steps in the Coagulation Process

The first coagulation in the conduit and basin results in a water of substantially zero color, with at least a theoretically slightly acidic reaction. This treated portion of the water, which has entered the basin chemically active, with the precipitate or floc forming rapidly, is then followed by untreated water in a quantity, because of the longer period of time, in excess of the treated water. The thorough mixing of this raw water with the treated water is brought about at the outlet of the submerged conduit as it displaces the basin water at this point. The second reaction begins at once and is carried to completion with a restoration of alkalinity to the entire supply, this action probably being consummated during the period which elapses before the next application of coagulated water.

The floc of the treated water has not had an opportunity to settle when the raw water is admitted, and readily furnishes a base about which the additional precipitation resulting from this secondary reaction forms, and serves to carry down color, sediment and bacteria mechanically, as well as through the chemical reaction which is taking place in every part of the untreated water as it mixes with the overdosed water. The resultant reduction of color is therefore due to the effect of dilution of the higher-colored water with water of no color; to the second reaction, which is in reality the completion of a reaction started under favorable conditions of overdosing, and which reaction chemically is always complete, as the excess of the applied coagulant is taken up by the alkalinity of the untreated water, resulting in the completion of the mass reaction; and also to the mixing of the floc of the fully treated portion with the mass of the entire day's water-supply, before it has the opportunity to settle. The precipitate thus formed in large part settles before it is carried to the filters.

In conclusion it may be said that the use of intermittent coagulation results in a saving in expense, uniform results of satisfactory quality, coagulation without exhausting alkalinities in soft waters and coagulation without excessive overloading of the precipitated hydrate on the filter beds.

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*Abstract of a paper read before the New England Water-Works Association at Portland, Maine, Sept. 13, 1916. The paper will be printed in full in the "Journal" of the association.

†Chief Engineer, Springfield Water-Works.

Holders of Activated-Sludge Patents are requested to correspond with Adams-Hydraulics, Ltd., manufacturer of sewage-disposal appliances, York, England.

Big Stack Falling from Broken Boom Tests Concrete Floor

By Henry Blood*

On Aug. 30 a section of steel boiler stack weighing 6,700 lb. was dropped 145 ft. to the roof of a two-story wing of the Pittock Block in Portland, Ore., by the breaking of the derrick that was hoisting it. The accident not only was interesting as a structural failure of a timber derrick, but it affords an exceptional example of the

FIG. 1. BOILER STACK ON THE DERRICK A FEW MINUTES BEFORE IT FELL.

ability of a good concrete floor to stand up under a most severe test.

The Pittock Block is a reinforced-concrete office building, erected in 1913. It is 200x200 ft. The south half is eight stories in height; the north half was designed for eight stories, but constructed only to the third floor, on which a temporary wooden roof, covered with tar and gravel, was placed. The roof framing consists of 4x4-in. caps and sills, and 4x4-in. posts spaced 5 or 6 ft. on centers in both directions. The third floor is a reinforced-concrete slab with girders and intermediate beams, and it was designed for a superimposed load of 90 lb. per sq.ft., using the stresses allowed by the Portland code.

The auxiliary steam plant of the Northwestern Electric Co. is located in the basement. It has a stack 10 ft. 6 in. in diameter, inclosed by two separated tile partitions and extending about 35 ft. above the roof of the eight-story wing before the new work was started. At times when the boilers were being forced to take on a heavy load, a considerable volume of smoke was emitted. This annoyed the tenants of a neighboring office building, and in an effort to abate the nuisance the company was adding 50 ft. to the height of the stack. This was in three sections; the lower one was 20 ft., weighing approximately 8,400 lb., and the upper two were 15 ft. long, weighing 6,700 lb. each. The first and second sections had been raised and riveted in place. The upper section was within 1 ft. 6 in. or 2 ft. of the top when the accident occurred. Fig. 1 is a view taken from the street, looking southeast, a few moments before the section fell.

The derrick had an A-frame composed of 14x14-in. Douglas fir timbers, with a vertical height of 45 ft. and a spread of 50 ft. It had no stiff-legs, but was guyed to the roof with two sets of steel cables, making an angle of 60° or 70° with each other, extending back about 50 ft. from the derrick and fastened through holes cut in the slab, around concrete girders. The base had a timber under each leg, connected by poorly made joints to a short girder built up from I-beams, with top and bottom plates, to form a seat for the boom. Back of this sill there were two diagonal timbers, and a center strut 12 ft. long. The boom was a single stick of Douglas fir 106 ft. long, 14 in. in diameter at the top and 22 in. at the bottom. It worked on a vertical pin 4⅛ in. in diameter. Its weight with fittings was about 6,600 lb.

The legs of the A-frame were connected at the top by two wide steel plates, 4 ft. 9 in. long. The front plate was ⅜ in. and the back plate $\frac{5}{16}$ in. thick. The lower corners of the back plate were cut off, so that they did not extend as far down the legs as the front plate. A

*Engineer, Bureau of Buildings, Portland, Ore.

FIG. 2. CLOSE VIEW OF BREAK IN DERRICK

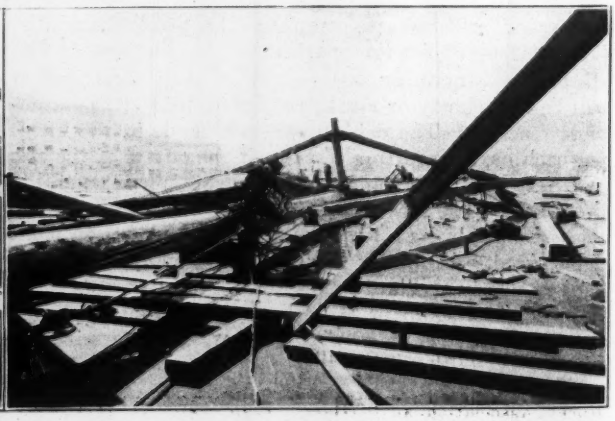

FIG. 3. THE COLLAPSED DERRICK ON THE ROOF

large number of bolts, mostly ¾ in., joined the plates and legs, some being below the back plate. A heavy forging passed through the plates near the top. It had an eye in each end. The center of the front eye was 2½ in. from the face of the plate; that of the back eye about 5 in. The boom guy was fastened by a link and clevis of 2¼-in. metal to the front eye. It was a six-part ¾-in. steel cable. The back stays were attached by a horizontal pin and shackle. The running line from the boom guy passed through a block held by a U-bolt near the bottom of the front plate. The derrick was set facing north on large timbers laid on the roof. A side guy ran from the end of the back shackle to the east wall, to take the strain when hoisting from the street over the west wall. The position of the derrick was not changed in doing this. Each stack section was set down on the roof before raising it to the stack.

All cables and connections appeared amply strong for the loads. The superintendent stated that the derrick was designed to handle 36 tons at an elevation of 30°. It was used in erecting the Broadway bridge and had been lying outside quite a while.

Two engineers of the Northwestern Electric Co. were on the roof watching the work, and they observed all steps of the failure. It was caused by the west leg of the A-frame twisting or tearing off just below the top connection. The boom fell in a vertical plane toward the north, struck on the firewall and broke off a few feet outside. The broken end, which was about 40 ft. long,

FIG. 4. THE FALLEN SECTION OF STACK STUCK IN THE TIMBER ROOF

fell close to the wall, the top end punching a hole through the wooden roof about 25 ft. from the wall and the broken end leaning against the wall at a window. The blocks swung violently against the wall, smashing windows at the fifth, sixth and seventh floors in the second row from the west corner. Several workmen, and employees in two or three offices, had narrow escapes.

The stack section struck with its nearer side about 40 ft. from the wall. It crushed the wooden roof to the concrete slab, but stopped on the latter and apparently did not seriously damage it. The frame of a skylight on which the upper end of the stack struck was bent at one corner, and some pieces of wire glass were broken loose. The well of another skylight a few feet away had a horizontal crack all around, 2 or 3 ft. below the top. The stack was flattened, and its angle rings were badly twisted. It had to be returned to the shop. A couple of small holes were cut through the main roof by sheave blocks, the firewall was slightly crushed, and pieces of brick were knocked from several window jambs.

The derrick kicked backward, not being fastened to the roof, struck a corner of the firewall and was turned

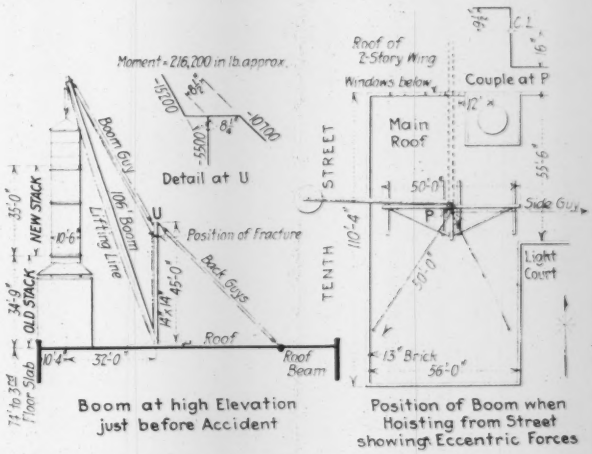

FIG. 5. DETAILS OF DERRICK WHICH COLLAPSED

toward the west. The base timber broke off near the east leg. No cables or connections were broken. Fig. 2 shows a close view of the top connection and primary break. Fig. 3 is a view of the stack as it lay on the roof. The photographs were taken the next morning.

Cause of Failure

The timber was not entirely sound, but no real decay was visible. It was seriously weakened by the bolt holes. There were three ¾-in. holes in a transverse row and two more only 2½ in. from them at the point of failure. The wood broke through all five.

There was an old crack or check about 2 in. from the outer face, extending for some distance along the fibers. It may have been caused by some previous strain. But even with these defects the stick was safe for a much larger direct load than it had.

In my opinion the break was due to a twisting moment on the derrick head produced by eccentricity of the guy connections. This was not nearly as large when the boom was at a moderate elevation as when it was in a high position. It was elevated at an angle of 70° or 72° from the horizontal at the time of the failure. An examination of the photograph shows that there would be considerable twisting in this position, which would cause tension in the front face of the legs. The connection of the boom lifting line to the bottom of the front plate added to this eccentric action. The direct stress in the leg was tension also.

But the heaviest twisting moment could have occurred when the boom was swung to the west to hoist from the street. It was then nearly parallel to the front of the A-frame, and its guy formed with the side guy from the east wall a couple having a lever arm of 26 in. or 27 in. The leg may have been slightly cracked by this strain and so weakened that when the boom was in its unusually high position it easily failed.

It is quite unlikely that there would have been a failure, if the top connection had been designed to avoid

eccentricity with the load in any position and if the side guy had not been attached to the back shackle. This is a detail that should receive more careful consideration. Derricks, hoists, scaffolding and other erection equipment should have proper design and inspection, as well as more permanent structures. They need not necessarily have the same factor of safety; this depends upon the importance and place of use. They should be sufficiently strong to avoid risk, and the details should not be weaker than the members they connect. This is not a criticism of anyone connected with the work.

Test of New Type Reinforced-Concrete Bridge

The Minnesota Highway Commission has developed a new standard design of reinforced-concrete bridge for short spans in which the volume of concrete is reduced by cells in the under side of the slab so as to form six longitudinal beams and also three transverse beams to distribute the concentrated load. This design saves about one-third of the volume of concrete required in the flat-slab type for the same load and using the same unit stresses.

In order to test this design and also to demonstrate the strength of reinforced concrete when built properly and under engineering inspection, the Commission constructed a model bridge from the plan shown in Fig. 1 as a part of their exhibit at the Minnesota State Fair, at St. Paul, Sept. 4 to 9, and arranged with the Experimental Engineering division of the State University to conduct a series of public tests.

This model was one-half size of a 23-ft. span, 18-ft. roadway bridge built under standard specifications of the Highway Commission by men in the bridge department acting as laborers. The slab mixture was one part cement, two and one-half parts sand and four parts gravel, hand mixed, and the reinforcement plain, square bars. The bridge was designed for a 20-ton traction engine with 15 tons on the rear axle. The unit stresses used were steel in tension 16,000 lb., in shear 10,000 lb., concrete in compression 650 lb., in bearing 400 lb. and in shear 50 lb. The forms for the cells are made of arched corrugated No. 26 iron with wood bulkheads which may be taken out, nested, moved to another bridge site and used again.

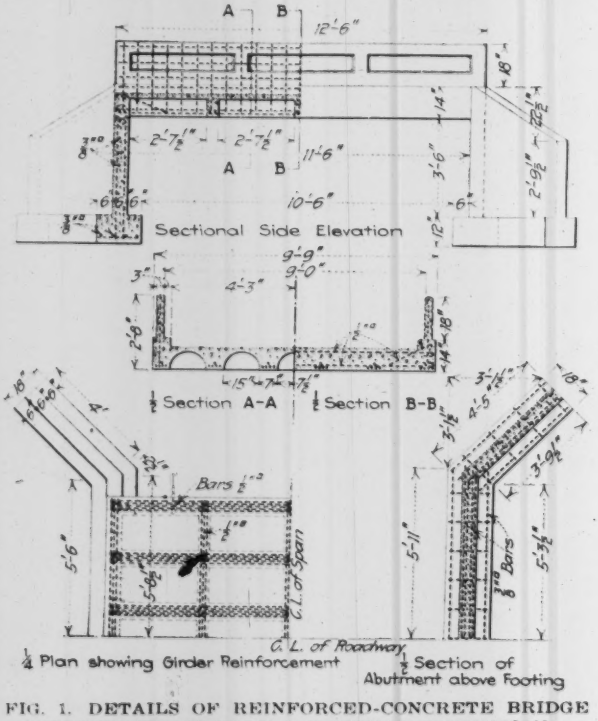

FIG. 1. DETAILS OF REINFORCED-CONCRETE BRIDGE TESTED BY MINNESOTA HIGHWAY COMMISSION

The bridge was cast June 19. Wooden plugs in contact with the steel were placed with the forms, to be pulled out later, and permit of strain-gage readings on the steel, and steel plugs were set in the top of the slab for compression readings in the bottom of the girder for deflection readings. Tests for shrinkage stresses were made at intervals between June 19 and Sept. 4, the opening day of the Fair.

A stone wagon was then placed on the bridge, pig iron being loaded on it over the rear axle in increments of

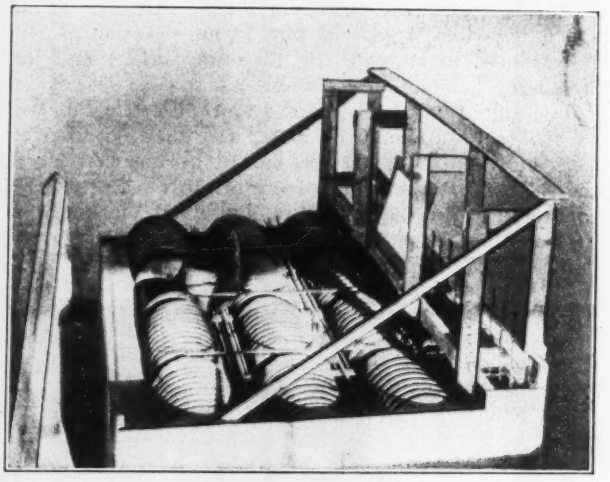

FIG. 2. MODEL OF FORMS FOR BRIDGE AS EXHIBITED AT STATE FAIR

2½ tons until the normal calculated load of 7½ tons was on, equivalent to a 20-ton traction engine on the full-size bridge. These loads were moved around to different positions, and readings extending over four days were taken at each position. The wagon was then removed and replaced by a platform support on two 6x42-in. timbers on which pig iron was piled at intervals until the calculated breaking load, 30 tons, was reached, equivalent to 60 tons on the full-size bridge.

The maximum longitudinal steel strains under the designed live-load was 3,800 lb. per sq.in. and the deflection 0.022 in. Under 20 tons concentrated on two 6x42-in. timbers the deflection was 0.06 in. at first and after 24 hr. 0.08 in. and the steel stress 4,800 lb. Under the breaking load after 4 hr. the longitudinal steel strain was 12,000 to 15,000 lb. per sq.in. and the maximum deflection 0.3 in.

As no cracks appeared anywhere in the bridge under the breaking load, excepting a cleavage crack along the back of the abutment indicating the bottom and side lines of the slab, on the afternoon of Sept. 9 the reinforced-concrete railings were broken down with sledge hammers. The girder effect of the railings, which were not figured in the design, was apparent in the slight deflection of the outside girder (0.1 in. as compared to 0.3 in. at the center). After their removal a hair crack appeared in

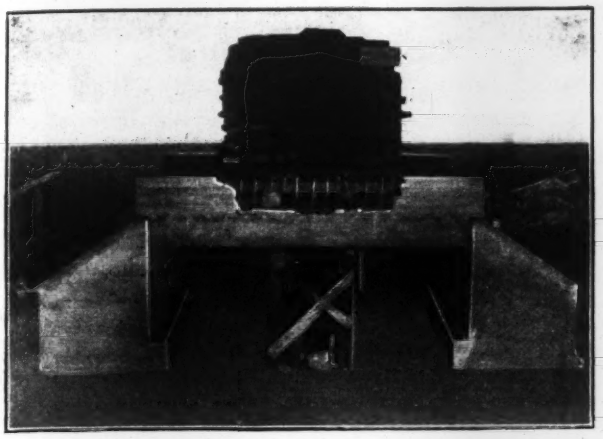

FIG. 3. TEST BRIDGE UNDER LOAD

the bottom edges of the outside girders at their center and their deflection was 0.35 in. Slight transverse cracks also appeared in the bottom of the cross girders. The bridge will be allowed to stand under this load for further developments.

A complete analysis of stresses as determined by the tests must be made before many deductions can be drawn, but in general the tests indicated that a safe and less costly type of bridge has been developed by the Minnesota Highway Commission; also that with insured engineering inspection higher unit stresses might be used in concrete highway bridges with perfect safety, with a still greater saving in cost resulting in the construction of more permanent highway bridges. The Highway Commission is now allowed 3% for drawing plans, supervision and inspection.

The bridge was designed and built under the supervision of C. E. Nagel, Bridge Engineer of the Highway Commission, and the tests were made by F. R. McMillan, Engineer of Tests, Experimental Engineering Department, University of Minnesota. A complete analysis will be made by Professor McMillan and published in a bulletin later.

Thacher Bridge Patent Loses in Iowa District Court

In the United States District Court, Southern District of Iowa, Central Division, Judge Martin J. Wade on Sept. 12, 1916, handed down a decision against the Thacher reinforced-concrete bridge patent (No. 617,615). The suit was by Edwin Thacher against the authorities of Polk County, Iowa, and was defended by the Department of Justice of the State of Iowa. The decision is by far the broadest of the three which have recently been made against the patent, inasmuch as it holds, first, that Thacher's swearing back of his invention before the von Emperger patent which it obviously infringes was not valid; second, that the "independence" of the reinforcement specified in the Thacher patent must be rigidly construed and third, that Thacher should be estopped from maintaining his patent because of laches in defending it through the first fifteen years of its existence.

Judge Wade's decision in the main, is as follows:

I do not pass upon the validity of the patent in so far as the same was affected by the prior art, or previous publication, except as the same is affected by the von Emperger patent. The patent to von Emperger embodies the idea upon which the plaintiff procured his patent, and I hold that the von Emperger patent was an anticipation of the patent granted to the plaintiff.

I also hold that the proof furnished to the patent office to establish the fact that the plaintiff's invention antedated the von Emperger patent, is not, in view of the evidence in this case, sufficient to justify a court in sustaining the claim of the plaintiff. Such proof must be at least "satisfactory and convincing." The proof in this case is not "satisfactory," nor "convincing." It is too uncertain to justify a court in setting aside letters patent.

So that in my view, the patent to plaintiff is invalid because anticipated by the von Emperger patent. In truth I am convinced that the only invention upon which the plaintiff procured a patent, was developed by him—not prior to the von Emperger patent, nor even at the time he filed application for his own patent, but that it really was invented by him, if at all, under the spur of repeated rejections by the patent office, of his application for a patent upon inventions entirely different from the one for which patent finally issued.

I agree with Judge Thomas in Thacher vs. Transit Construction Co., 228 Fed. 906, that the Thacher patent is specifically limited by the language "each bar of a pair being independent of the other." The proceedings in the patent office, and the proof as to the prior art, clearly convince me that it was only by reducing his claims to this specific description, that plaintiff ever procured a patent; in fact, a broader construction would in my judgment render the patent void because of the prior art, aside from the von Emperger patent. But whether it would or not, the proceedings in the patent office clearly makes effective the self-imposed limitation, that the bars to come within the scope of the patent must be each "independent of the other."

Under this construction of the plaintiff's patent, even if it were valid, there was no infringement in this case. The bars used in the construction in issue are not "each independent of the other." The bars are a part of a rigid or semirigid structure, consisting of longitudinal and cross-bars and lattice bars, all firmly bound together by wire ties at intersections.

I am convinced upon the whole testimony that the cross-bars and lattice bars and ties have functions to perform. I cannot agree with the apparent theory of Mr. Thacher as a witness that these serve only the purpose of maintaining the independent bars in place during the construction. If anything were necessary to convince me that the construction used by the defendants does not consist of pairs of bars each bar "being independent of the other," I find it in the letters written by Thacher himself through many years. These appeals by Thacher for use of the Melan and von Emperger types in preference to his own, and the failure to use the strictly independent bar system in any construction, so far as the record discloses, convinces me that Thacher himself recognizes that cross-bars and ties and lattice bars used with longitudinal bars have a function and a purpose in concrete construction; in fact it is quite apparent from the record in this case, that limited strictly to the bars independent of each other, in no manner connected, or held together, or held apart, the Thacher invention is not, and has not been, of practical use. Without further discussion of the evidence, I am convinced that there is no infringement in this case.

I am also of the opinion that the plaintiff is estopped by laches from asserting any such construction of his patent as would bring the structure involved in this case within its meaning.

This patent was issued in 1899; it expired before this case was tried. During all the years from the issuance of the patent up to the present, the plaintiff has been in close touch with concrete construction all over the United States. For years, bridges and other structures have been erected which come as near infringing the plaintiff's patent as does the structures in controversy and no action was ever brought by the plaintiff until 1913 or 1914—fourteen or fifteen years after the issue of his patent. The plaintiff permitted individuals and municipalities to proceed apparently in good faith, with private and public work, and made no protest until a comparatively short time before his patent expired. In fact I am convinced that the plaintiff's present view of the construction of his patent as including structures such as those in controversy, is a discovery made by him or some one else within recent years. I do not believe, during all these years when he quietly allowed those he now claims to be infringers to proceed without asserting any right, that he understood or believed that these structures came within the claims of his patent.

There will be a decree dismissing the plaintiff's Bill and judgment against the plaintiff for costs.

Prominent Bridge Engineers Express Regret

The editors of *Engineering News*, after the publication of the issue of Sept. 14 with the account of the accident at Quebec, invited a number of prominent engineers to comment on the disaster. The following replies were unfortunately crowded out of the issue of Sept. 21:

The accident proves again the fallibility of the human mind even where highest qualifications are in commission. The failure seems to be chargeable to an erection plan containing a casting that failed, thus producing eccentricity and the kicking out of the supporting girder.

The first Quebec Bridge failure was due to an erroneous compression formula and too small a purse. Engineers who have studied the present design and seen the work now standing have been profoundly impressed with the great advances represented over the old design. Engineering follows the rules of evolution the same as every other art; only in engineering the inexorable laws of nature expose our troubles where other professions do not reveal them. The shoulders of the engineering profession are strong and courageous, and this failure will be translated, I am sure, into a fine success by the very men whose responsible souls have been so severely tried by this accident.

Some engineers will say, "Of course, the design at this point was bad," and so on, but such critics have done little in life but criticize.

I am sure that the engineering profession will be strengthened by the accident and that the present organization will carry to complete success this very bold undertaking. The general public, often indifferent to the multitude of responsibilities that have to be absolutely solved in every detail, may be here awakened to the extent of the exactions of our profession, for it is quite likely the casting was only one of ten thousand problems in this structure of equal importance to final success.

HUGH L. COOPER.

101 Park Ave., New York City, Sept. 14, 1916.

I did not have the benefit of first-hand observation, but have had the report of two other experienced eye-witnesses. It was evident to all observers that the contractors, the St. Lawrence Bridge Co., had spared no care or expense to make a perfect success of this unprecedented operation, and they should receive every sympathy, particularly from the engineering profession, which profession appreciates that, in the great strides made from time to time, the pioneers are called upon to pay the toll of advance experience. There is no reason to be discouraged in the slightest degree; the contractors will ultimately complete the work promptly and successfully.

I think it is plain there was no defect in the design of the main structure, either in the cantilevers or in the suspended span, that contributed to the disaster. It would be presumptuous on the part of any member of the profession to make any suggestion as to the cause of the disaster in advance of the report of the contractor, whose engineers and field forces are entirely competent and are the only ones in a position to know the sequence of events that actually led up to the trouble. I well know they may be depended upon to enlighten the profession fully and completely.

JOHN STERLING DEANS,
Vice-President and Chief Engineer, Phœnix Bridge Co.

Phœnixville, Penn., Sept. 15, 1916.

The second failure seems to have originated like the first—from a cause which would be apparent to the mechanic.

As the shopman questioned the make-up and lacing of the chords of the first ill-fated design, so in like manner the mechanic familiar with the use of jacks and the trouble incident to "kick" would be inclined to expect more than the usual difficulty owing to the carefully hinged bolster support built up high upon the stirrup girder.

A safe and cheaper support would have been secured had a low flat shoe well bolted to the top of the girder been employed with stiff chords in the end panels.

There is no new lesson apparent in the collapse further than to emphasize to us all the ease with which some of the best of us may overlook the simplest and most obvious things.

The unsurpassed skill exhibited in floating and swinging the great span has unfortunately gone for naught because of the insufficiency of a mere trifling detail.

C. A. P. TURNER.

Minneapolis, Minn., Sept. 15, 1916.

Temporary Rock-Fill Dam on Colorado River

During the past August a temporary rock-fill dam was built across the Colorado River by the Imperial Irrigation District under the direction of C. R. Rockwood, chief engineer. The purpose of the dam was to divert the low-water flow of the river into the main irrigation canal of the district and thus save irrigated crops in the Imperial Valley. During June, it is explained by Mr. Rockwood, the flood flow of the river leaves an enormous deposit of silt, building up the canal bottom, while at the same time erosion of the river channel causes the river bed to fall. When the peak of the flood is past, the river generally falls very rapidly, resulting in a low river bed and a high canal bottom. Several months are required for the gradual filling up of the channel and erosion of the canal bottom to establish an equilibrium.

In 1910 a rock-fill dam or weir was placed in the Colorado River under the direction of Mr. Clark, then Chief Engineer of the California Development Co., at that time the owner of the canal. From 1910 until this year the Government has refused repeated requests for permission to construct another rock-fill weir. In 1915, however, permission was granted by the Government for a temporary hydraulic-fill dam across the Colorado River. The construction of this dam was described in *Engineering News* of June 22, 1916, pp. 1170-71.[1]

The construction of a hydraulic-fill dam in the Colorado is not possible, except at times of very low flow. Such a flow did not occur this year, and consequently permission to construct the rock-fill dam was a godsend. It should be understood that these dams, whether hydraulic fill or rock fill, have to be removed before the river again goes into flood.

The construction of the rock-fill dam this year has been thus described for *Engineering News* by Mr. Rockwood:

We have had for years a standard-gage railroad track running from our quarries at Andrade to our intake at the river. From this track we threw a spur across the river at right angles to the direction of flow. The river channel at this point is 650 ft. wide, and the trestle was 700 ft. long. The trestle was an ordinary four-pile bent, 15-ft. span structure. From the trestle we dumped rock on either side, carrying first a thin blanket of rock across the channel, gradually raising it until we had a sufficient amount of rock in the channel to divert the required amount of water to the canal. We used no rock exceeding ½-cu.yd. capacity. All of it was loaded with steam shovels.

We used for hauling rock 12- and 16-yd. air-dump cars and have placed a total of 1,146 cars to date (Aug. 28). The weir was completed 10 days ago, and the only rock that is now being used is for repair work where some slight breach occurs in the top of the dam.

We shall remove the trestle in October and before the approach of next summer's floods will remove the rock, or as much of it as may be necessary to avoid seriously obstructing the channel during flood.

Electrification of the St. Gothard Ry. in Switzerland has been undertaken by the Swiss Government, which is spending about $600,000 on the work this year and will eventually spend about $7,500,000. The length of line to be electrified is about 68 mi. Two power stations are being built, one at Amsteg where the water of the river Reuss is utilized under a head of 900 ft. and the other at Piotta where the head of water is 2,642 ft. and 39,000 hp. will be developed. The commission appointed to investigate as to the system of electrification to be adopted has recommended a single-phase system similar to that used on the Lötschberg tunnel line.

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[1]The description mentioned was taken from a paper by J. C. Allison, of Calexico, Calif., Chief Engineer of the California Development Co., printed in the May "Proceedings" of the American Society of Civil Engineers. The paper was read before the society on Sept. 6, 1916.

News of the Engineering World

Railway Roadmasters Meet

The thirty-fourth annual convention of the Roadmasters' and Maintenance of Way Association, held in New York City, Sept. 19 to 22, was the best attended on record. Over 250 members were registered, and there were 57 exhibitors of track appliances and appurtenances.

The committee reports on the "Seasonal Distribution of Maintenance Work and Forces," on "Recommended Practice for Anchoring Track, Uniform Spacing of Ties and Elimination of Slot Spiking," and on "Equating Track Values" were the principal features of the meeting.

The committee on seasonal distribution of maintenance work reported in favor of a monthly payroll allowance and a yearly material allowance. That monthly payroll allowance gives greater elasticity in labor hire and that yearly material allowance results in greater economy in purchases were the contention.

The discussion showed much difference of opinion on both these heads, some favoring a permanent section force the year round and others expressing themselves against the maintenance of a considerable labor force during the comparatively idle winter months. The experience of the Long Island R.R., described by Coleman King, supervisor, has shown that the gain in efficiency resulting from permanent employment pays the railroad for the unproductive time during the winter. Moreover, it has assured the railroad of plenty of labor at a time when other roads were suffering from shortage of labor. The experience of the Buffalo, Rochester & Pittsburgh Ry. has been much the same.

The report of the committee on anchoring track outlined the damage done by creeping rails and strongly advocated the economy of rail anchors, which it was estimated, save approximately $250 to $400 per mi. in tie renewals, driving back rails, squaring up slewed ties, surfacing track, etc. In the discussion it developed that some thought this too high an estimate of saving. It was stated that both the New York Central and the Canadian Pacific lines are using track anchors on single- as well as on multiple-track lines.

The spacing of ties, the committee reported, should be a uniform distance between edges instead of a uniform distance center to center. The recommended method gave uniform bearing for the rail irrespective of the width of the tie, although the time honored method is to place so many ties per rail length. The committee reported against joint fastenings slotted for spiking, which were held to be an ineffective method of preventing rail creeping and only tended to weaken the track and increase maintenance expenses.

The committee on equating track values outlined the following course to be pursued: (1) Classification of railroads on basis of traffic handled; (2) determination of proper standard of maintenance for main track, sidings, switches, etc.; (3) the selection of special test sections of track from which accurate records of labor distribution, etc., could be compiled.

From available data the committee prepared the following table of recommendations:

Class		Force: 1 Foreman and	Equiv. Mileage of Sect.	Men per Mile with Foreman	Men per Mile without Foreman	Miles per Man with Foreman	Miles per Man without Foreman
A. Double-track lines	S	6 men	9	0.78	0.67	1.29	1.50
	W	3 men		0.44	0.33	2.25	3.00
A. Single-track lines	S	4 men	6	0.83	0.66	1.20	1.50
	W	3 men		0.66	0.50	1.50	2.00
B. Single-track lines	S	4 men	7	0.71	0.57	1.40	1.75
	W	2 men		0.57	0.43	1.75	2.33
C. Single-track lines	S	3 men	8	0.50	0.37	2.00	2.67
	W	2 men		0.37	0.25	2.67	4.00

The following officers were elected: President, M. Burke, roadmaster, Chicago, Milwaukee & St. Paul Ry., Chicago; first vice-president, A. Grills, superintendent of track, Grand Trunk Ry., St. Thomas, Ont.; second vice-president, J. B. Oatman, Buffalo, Rochester & Pittsburgh Ry.; secretary, P. J. McAndrews, roadmaster, Chicago & Northwestern Ry., Sterling, Ill.; treasurer, W. H. Kosmehl, Elgin, Ill. The newly elected officers of the Railway Supply Asociation are: President, R. A. Van Houton, Sellers Manufacturing Co., Chicago; vice-president, E. T. Howson, engineering editor, *Railway Age Gazette*, Chicago; secretary-treasurer, W. C. Kidd, Ramapo Iron Works, Hillburn, N. Y.

Port Authorities Meeting Held at Montreal

The fifth annual convention of the American Association of Port Authorities was held at Montreal, Sept. 13 to 15, with a large and representative attendance from all parts of the United States and Canada. W. G. Ross, President of the Montreal Harbor Board, spoke of the advantages of annual gatherings as productive of harmonious international coöperation and dealt at length with the benefits of the public as compared with private control of harbor facilities. Until recent years organization in American ports has been in the hands of interests or railroads vying with each other to capture freight and secure the best competitive terminals. Of late, however, public control is being instituted for private ownership, and almost every seaport of note will presently be organized in this manner. Mr. Ross explained conditions in Montreal, where there are no wharves under private ownership and the jurisdiction of the Harbor Commissioners extends over a distance of 17 mi., including both sides of the River St. Lawrence. Thomas R. Williams, of the Board of State Harbor Commissioners, San Francisco, read a paper on concrete wharf supports.

Robert Bridges, President of the Seattle Port Commission, read a paper on the British policy of national control of ports, as exemplified in Canada at Montreal and Vancouver, where the Harbor Boards are appointed by the Canadian Government. This policy keeps public control of access to the ocean; and if private individuals construct wharves out to deep water or become squatters

on tide lands, the Government has only to pay the value of any improvements and order them off. The American attitude as regards public control of ports is changing and the completion of the Panama Canal is a great stimulus to port improvement.

F. W. Cowie, Chief Engineer of the Harbor of Montreal, gave an address on "Canadian Ports," pointing out the difficulties of the problem of providing transportation facilities for Canadian produce, owing to the climate and the great distances to be traversed through a sparsely settled country. That this problem has not been solved may be judged from the fact that of 312,000,000 bushels of wheat shipped from the head of the lakes during 12 months, 161,000,000 bushels were diverted to American ports.

The delegates were entertained at luncheon by Mayor Martin and in the evening were banqueted by the Montreal Harbor Commission. The delegates inspected the railway terminals, elevators and other facilities of the harbor and were entertained at luncheon by the Shipping Federation of Canada.

The following principal officers were elected: President, W. G. Ross, Montreal; Secretary, W. J. Barney, New York; Treasurer, Harry C. Gahn, Cleveland. It was decided to hold the next convention in Cleveland, Ohio.

Activated Sludge in India

Activated-sludge studies at three points in India, with particular attention to fertilizer possibilities, are to be made by Dr. Gilbert J. Fowler, who was for many years chemist and superintendent and then consulting chemist of the sewage works of Manchester, England, and whose pioneer activated-sludge work is well known by sanitary engineers. Some months ago Dr. Fowler became Professor of Applied Chemistry at the Indian Institute of Science, Hebbal, Bangalore, India. Under date of July 28, 1916, Dr. Fowler wrote *Engineering News* that he expected experimental activated-sludge plants would be installed in connection with the Institute at Hebbal, and also at Calcutta and Hyderabad.

New Chicago Railway Terminal To Cost $20,000,000

Tentative plans for the new terminal station of the Illinois Central R.R. at Chicago have been submitted to the City Council committee on railway terminals. These plans provide for the use of the new station, not only by the roads now entering the present station, but also by those using the Dearborn Station and possibly by those using the La Salle Station. The location will be at the southeast corner of 12th St. and Indiana Ave. Both of these thoroughfares are blocked by the present station, but will be continued past the new station. The headhouse will be about 700x200 ft., four stories high, and in architectural design it will harmonize with the neighboring Field Museum. The trainshed and platforms will extend nearly to 16th St. A Bush type of tramshed will be used.

A special feature of the design is that it is to be a three-level terminal. The top deck, level with the new 12th St. viaduct, will have the main passenger floor, with 24 tracks. At the street level will be the express and mail handling platforms, while below this will be the suburban tracks. These last tracks will be depressed in a subway beginning at about 22nd St., and (as at present) will extend beyond the main-line terminal station to the suburban terminal at Randolph St. The lower platform may later be developed for through passenger traffic.

Electrification of the suburban lines is proposed as part of the project. The total cost is estimated at $25,000,000. More complete plans have been called for by the city, including plans for such a station as would be required if the other railways continue to use their present terminals.

Opinions on Building Vibration Collected by Contractors

An inquiry on the seriousness and injurious effects of vibration in buildings containing machinery is summarized by the Aberthaw Construction Co., 27 School St., Boston, in a little pamphlet just issued under the title, "The Effect of Vibration in Structures; Preliminary Report of the Aberthaw Investigation." The summary is based on several hundred replies.

Concerning the effect on workers, this citation is typical: "Under certain conditions it was impossible for our employees to stand it for a very long time. . . . In the case of women it seemed impossible for them to stand the vibration even temporarily on account of its nervous effect." In another plant a case of paralysis of the legs was attributed to vibration.

The amount of vibration involved in severe cases of unstable buildings appears to be rather indefinite. One descriptive remark, which may be exaggerated for effect, relates to an extraordinarily bad case: "I have seen mill buildings vibrating so much from the movement of machinery that a half-filled pail of water placed upon the upper floor would spill over."

A few cases are reported of vibrations due to machinery so severe in character as to injure the structural strength or stability of the building. In the case of a set of belted grinding machines the machines when set on the floor vibrated badly; the vibration "was so severe that it would be only a question of a short time until we would have had to repair the brickwork." In another case shafting was thrown out of alignment, owing to the distortion of the building. In another case: "We have often been obliged to reline shafting, and also after adopting higher rates of speed we found it necessary to install additional posts supporting several floors."

Taking repairs as evidence of structural injury, a very decided statement says: "In all cases the loading of the floors is within the safe limits of the floor construction, but we have found that the vibrations in many instances have caused the loosening of the floor-joist supports in the walls and have in some cases made repairs necessary to the building."

Increase of output, possibility of doing more delicate work, and greater freedom from stoppage of work on such machines as looms and spinning frames are reported in a considerable number of cases. By putting a machine on a solid foundation "the increased output by making this change was almost 40%, owing to the fact that the operator could take measurements with the machine running when there was no vibration, but was unable to do so when vibration was so great. The quality of the work was also

greatly improved." Putting grinding machines on a solid foundation "increased the grinding capacity of the machines possibly 10% without using any more wheels." In textile mills before stiffening up the building by pilasters and new flooring "there was a great deal more repairs on looms and therefore necessarily less production." Also "a rigid loom placed on a firm foundation will turn out better work and more of it than one of lighter frame subject in itself to vibration and standing on a vibrating floor. The same is true of carding machines." Foreign fabrics are thought to be better than some of the American fabrics because of more attention abroad to building construction and solid setting of the machines. It has been estimated that about 10% increase in output may be effected by eliminating vibrations in textile mills.

A printing concern reports that since moving into a rigid modern building from an old brick and wooden building it can run its presses 20% faster. A chemical laboratory reported much difficulty in weighing on the laboratory balances, owing to vibration, and cure of this trouble by moving into another building. A machine-tool manufacturer says: "We have difficulty in taking fine measurements where very sensitive indicating mechanisms, both mechanical and optical, are used."

There is comment from a few in the direction of indicating rapid "crystallization of machines and machine parts where they rest on concrete floors or otherwise have vibration transmitted directly to them by rigid connections." This testimony is of uncertain tenor, however. In other cases there is trouble from breakage of machines where they are set on very rigid supports; and in general it is evident that the question of flexibility or cushion effect is bound up with the question of vibration influences.

ENGINEERING SCHOOLS

University of Arizona

The University of Arizona has added to its curricula a four year course in architectural engineering, which work will be offered beginning in September of this year.

University of Texas

A four-year course leading to the degree of B. S. in Mechanical Engineering will be offered this fall for the first time. The new work offered will include machine design and operation, steam- and gas-power engineering, refrigeration, and manufacturing methods. Additional lecture rooms, laboratories, offices shops and drafting rooms have been secured by the erection of a new power building on the campus. A larger amount of new equipment has been secured.

University of Iowa

This institution has abandoned its four-year course in chemical engineering and substituted a five-year course which it has aimed to make as complete as any offered in the country. Besides the formal course of study, the students will be required to make at least two inspection trips and spend two six-week periods in employment at some industrial plant.,

Two combined business and technical courses have been established jointly by the College of Applied Science and the Department of Economics of the Liberal Arts College. One is for the business end of chemical industries and one for work when the fundamentals of engineering practice must be known. The latter course has been established to meet the demand for city and industrial-plant managers, engineering salesmen, etc. The number of electives in this course allows the student to lean toward mechanical, electrical or civil engineering fields.

Oglethorpe University

The President and Board of Directors have just announced the formal opening of Oglethorpe University, at Atlanta, Ga., on Sept. 20. The announcement goes on to say that:

> The total subscription in the present campaign for the founding of Oglethorpe as a great Presbyterian university in the South is rapidly approaching $1,000,000, the goal set being $3,000,000. Ground will soon be broken for additional buildings. The University includes the following schools: Liberal Arts, Literature and Journalism, Commerce, and the School of Science leading to B. S., M. S., and Ph. D. degrees.

NOTES

City Manager Wanted by Portsmouth, Va.—Applications accompanied by recommendations will be received by L. P. Slater, City Clerk, until Oct. 20, 1916, at noon, marked "Application for position of City Manager, Portsmouth, Va." The population of Portsmouth by the 1910 census was about 33,000.

The Slide on the Panama Canal, which tied up traffic from Aug. 30 to Sept. 7 inclusive, for ships drawing over 17 ft. of water, was due to the sudden movement into the canal prism of a large rock in the base of the Cucaracha slide. This rock mass was very hard and compact, and it was necessary to drill and blast it before the dredges could remove it.

Employment Agencies in Pennsylvania which furnish laborers for engineering and construction work, and all other private labor agencies, must obtain from the State Department of Labor and Industry before Oct. 1 new licenses, for which a fee of $50 and a bond to the amount of $1,000 are required. Receipts on standard forms must hereafter be issued by the labor agencies to every person who pays them for the purpose of obtaining employment.

Pennsylvania Turnpike Ordered Paved—Following a joint complaint by the motor clubs of Harrisburg and Lebanon, Penn., the Public Service Commission of Pennsylvania has ordered the Berks and Dauphin County Turnpike Co., which operates a toll road between Hummelstown and Wernersville, a distance of 35 mi., to rebuild a section of the road between Palmyra and Myerstown, a distance of 17 mi., before July 1, 1917. The other parts of the road must be put in repair before that date. The commission has specified a concrete base for the part to be rebuilt. This order of the Public Service Commission is looked upon as a sweeping precedent and a number of similar complaints are expected.

The Engineering Foundation, founded a year ago by Ambrose Swasey, of Cleveland, has elected as its first Secretary Dr. Cary T. Hutchinson, of New York City. Dr. Hutchinson's name was selected from a list of 16 candidates considered by the board of trustees. Dr. Hutchinson was born in St. Louis in 1866, where he graduated at Washington University. He tooks a post-graduate course in physics at Johns Hopkins University under Professor Rowland. He is widely known for his work in electrical engineering and his contributions to engineering literature. For some time he was a member of the firm of Sprague, Duncan & Hutchinson, but has in recent years been in independent practice in connection with electric railway construction and hydro-electric development. He was Chief Engineer of the McCall Ferry Power Co. and Consulting Engineer for the Great Northern Ry. in the electrification of the Cascade Tunnel. Dr. Hutchinson has also been selected as the Secretary of the National Research Council, recently organized under the auspices of the National Academy of Sciences. In addition to the funds available from the original endowment by Mr. Swasey, an additional contribution of $5,000 for the current year has been made by Mr. Swasey, to meet the expenses incident to the organization of the Foundation's work.

A Barge Built of Concrete recently completed in Norway has been widely heralded in newspaper dispatches as the

first vessel of this kind to be built in the world. Many engineers will recall that previous vessels of this type have been built in the United States. Some reinforced-concrete barges were built at Panama and were used to support the hydraulic pumping machinery used for lifting excavated material in some of the dam construction. Two concrete barges were also built in 1912 and 1913 at Fairfield, Md., by the Arundel Sand and Gravel Co., of Baltimore, Md. The boats were about 112 ft. long and 28 ft. beam. One of them was abandoned early in the present year but the other is still in service.

The Mississippi River Bridge or Tunnel projected by the City of New Orleans must be begun by May 1, 1920, and completed within five years thereafter, according to the terms of the constitutional amendment on which the electors of Louisiana are to vote on Nov. 7. As stated in the note referring to this projected bridge or tunnel in "Engineering News," of Sept. 7, 1916, p. 477, the project is in charge of the Public Belt Railroad Commission of New Orleans. The Commission has received applications from a number of engineers for appointment as chief engineer of the work and announces that it is desirous of hearing from any other firm of engineers whose record of work performed and general reputation as bridge or tunnel engineers will warrant their consideration for so large and important an undertaking. Wm. B. Bloomfield, of New Orleans, is the Chairman of the Commission.

Coke-Oven Byproducts of the plants of the United States amounted to nearly $30,000,000 in 1915. The manufacture of coke is an industry that is on the increase, as evidenced by the fact that last year's income for byproducts was greater than the previous record by $17,500,000. Numerous plants are being erected at the present time. One of special interest on account of its location is on the Hackensack meadows, Jersey City, N. J., that is designed to work up in the New York district an interest in domestic coke. Although there were material increases in the output and value of gas, tar and ammonia—as was to be expected in view of the greater output of byproduct coke—the increase in benzol products presented the most interesting feature of the year. The value of these products rose from less than $1,000,000 in 1914 to more than $7,760,000 in 1915, according to the United States Geological Survey. In 1914 there were 14 benzol plants in the United States, all controlled by one company. Last year 16 additional coke plants were equipped with benzol apparatus. The benzol products obtained in 1915 amounted to 16,600,657 gal. More than 13,000,000 gal. of the total output was crude light oil, having an average value of 33c. per gal.

The High-Pressure Fire-Service System of Boston, on which work has been delayed many times by the failure of the authorities to agree upon a pumping-station site, may not be completed as originally planned, as a cheaper layout has been recommended by Joseph Rourke, engineer in charge of the project. The design included a station with electrically driven pumps of 18,000 gal. per min. capacity at 300-lb. pressure and with provision for additional units at some later time. Owing to a dispute with the Edison Electric Illuminating Co. regarding rates to be charged for power, studies have been made for a smaller station to contain pumps of 6,500 gal. per min. capacity at 240-lb. pressure, driven by gas engines. The remarkable increase in the amount of sprinkler equipment in hazardous-risk buildings and the enactment of new and strict fire-prevention laws have made the larger capacity unnecessary in the opinion of the engineer, and the saving in cost at the station would enable the city to build about 11½ mi. of pipe system instead of the 6½ mi. contemplated with the original appropriation. An objection to the proposition is that the city contracted for a pump with electric equipment at a cost of about $176,000 over two years ago, and it would be necessary to obtain release from this obligation.

A Water-Storage Project in Connecticut, to increase the flow of water in the Naugatuck River, during low-water periods, is being promoted by a number of the principal manufacturing concerns in the Naugatuck Valley. The Naugatuck River drains an area of 326 sq.mi. above its junction with the Housatonic. There are many dams and mill ponds on the river and its tributaries, and during the four dry months of the year there is very little water flowing in considerable stretches of the river. The population discharging sewage into the river is estimated at 140,000, and it receives a large amount of manufacturing waste in addition. The banks of the river are coated with a heavy layer of decomposing sludge and other deposits. Two years ago the principal manufacturing concerns in the cities along the course of the river held meetings and raised funds for the purpose of investigating the possibilities of water storage to supplement the dry-weather flow. Chas. H. Preston, Jr., Waterbury, Conn., was engaged as engineer, and has made plans for a storage reservoir on Lead Mine Brook. After investigating various possible sites for the dam, one was chosen which permits the storage of about 3½ billion gallons of water, or 10,477 acre-ft., at a cost of $914,500 or $87.29 per acre-ft. The dam will be 1,300 ft. in length and 142 ft. in maximum height. Assuming that this reservoir were emptied at a uniform rate beginning June 1, it would provide a stream 125 ft. in width with a velocity of 3 mi. per hr., 2½ in. deep, for 12 hr. each day and 6 days each week, for the period from June 1 to Oct. 1. The dam will be a gravity dam of cyclopean masonry. The foundation conditions are very favorable. A solid ledge extends across the valley the entire length of the dam, with only 5 to 6 ft. of earth covering. Plans for the dam have been approved by the State Board of Engineers. Further prosecution of the enterprise is to be considered at a meeting of the manufacturers interested on Sept. 14.

PERSONALS

R. R. Feller has been made County Engineer of Wood County, West Virginia, to succeed Burdette Woodyard, resigned, as noted elsewhere.

R. P. Boyd has resigned as Assistant State Highway Engineer of Alabama to take charge of a half million dollar road improvement project at Monroe, La.

W. F. Fourrier has been appointed Assistant Engineer of the Atchison, Topeka & Santa Fe Ry., Coast Lines, at Needles, Calif., to succeed B. H. Quinham, resigned.

C. W. Hays, formerly with Boyts, Porter & Co., Connellsville, Penn., is now in charge of the pump department of the Ross Mechanical Supply Co., Pittsburgh, Penn.

H. E. Stevens, M. Am. Soc. C. E., Bridge Engineer of the Northern Pacific Ry., has been promoted to be Chief Engineer, succeeding William E. Darling, resigned, as noted elsewhere.

T. F. Malloy has been appointed Engineer of the Falls and Sewell Mountain road districts of Fayette County, West Virginia, where highway improvement involving the expenditure of $350,000 is to be done.

Edward St. C. Smith, Assoc. M. Am. Soc. C. E., Consulting Engineer, Boise, Idaho, has been appointed Engineer in charge of highway construction of the Piedmont road district of Mineral County, West Virginia.

John Martin, former chief bookkeeper of the Cleveland, Ohio, Water Department has been appointed Deputy Commissioner to succeed Charles P. Jaeger, resigned, as noted in these columns of last week.

Harold E. Ketchum, Superintendent of Construction on the Detroit-Superior High Level bridge for the Hunkin-Conkin Construction Co., has accepted a position with the Graff Construction Co., Seattle, Wash.

Henry R. Beebe, Assoc. M. Am. Soc. C. E., of Utica, N. Y., is the candidate for State Engineer of New York on the Democratic ticket. The Republican candidate is the present State Engineer, Frank M. Williams.

George S. Wheatley, Jun. Am. Soc. M. E., formerly Instructor in Mechanical Engineering at the University of Pennsylvania, has accepted a position with the engineering department of the Cambria Steel Co., Johnstown, Penn.

William A. Bartlett, Jun. Am. Soc. C. E., of Colorado Springs, Colo., has been appointed Resident Engineer on the construction of a coal unloading station to be constructed for the American Brass Co., at Stratford, Conn.

J. B. Converse, of Selma, Ala., for several years Resident Engineer of the Alabama State Highway Department, has been promoted to be Assistant State Highway Engineer, succeeding R. P. Boyd, resigned, as noted elsewhere.

Norman F. Strachan, of Dallas, Tex., has been appointed Assistant Engineer of the Kansas State Board of Health. He is a graduate of the University of Kansas and has been employed by Myers and Noyes, Consulting Engineers, Dallas.

Burdette Woodyard, former County Engineer of Wood County, West Virginia, has been appointed Engineer of the Walton and Spencer road districts, Roane County, West Virginia, where nearly half a million dollars is to be expended.

R. J. Parker, General Superintendent of the Eastern lines, Atchison, Topeka & Santa Fe Ry., has been promoted to be General Manager of the Western lines, with headquarters at Amarillo, Tex., succeeding Fred C. Fox, promoted as noted elsewhere. He began his railway work in 1872 as a brakeman.

Fred C. Fox, General Manager of the Western lines of the Atchison, Topeka & Santa Fe Ry. at Amarillo, Tex., has been promoted to be General Manager of the Eastern lines at To-

peka, succeeding the late Charles W. Kouns. He began his railway experience in 1880 as a telegraph operator.

James M. Herbert, former President of the Colorado, Wyoming & Eastern Ry., Laramie, Wyo., has been elected President of the Missouri Bridge and Terminal Co., St. Louis, Mo., succeeding the late F. H. Britton. He was recently elected First Vice-President of the St. Louis Southwestern Ry.

H. A. Lane, M. Am. Soc. C. E., Assistant Engineer of Surveys of the Baltimore & Ohio R.R., has been promoted to be Assistant to the Chief Engineer, with headquarters at Baltimore, Md. He has been with the Baltimore & Ohio since 1902 and has been Assistant Engineer of Surveys since 1910.

Henry Welles Durham, M. Am. Soc. C. E., County Engineer of Bergen County, Hackensack, N. J., and former Chief Engineer of the Bureau of Highways, Borough of Manhattan, N. Y., is a corporal in the Seventh New York Regiment on the Mexican border. He has recently returned to his regiment in Texas after two months' furlough to attend to his other public duties.

Edward Raymond, who was recently appointed General Superintendent of the Eastern district, Eastern Lines, Atchison, Topeka & Santa Fe Ry., has the distinction of being one of the few high operating officials who has come up from the track department as section foreman and roadmaster to trainmaster and superintendent. He has been continuously with the Santa Fe since 1877.

George B. Dusinberre, M. Am. Inst. E. E., Consulting Engineer of Wellsboro, Penn., formerly Manager of the Westinghouse Electric and Manufacturing Co. at Cleveland, Ohio, has been appointed Commissioner of the Cleveland Water Department. He is a mechanical engineering graduate of Cornell University and for many years was with the Westinghouse companies in this country and in England.

F. H. Tillinghast, M. Am. Soc. C. E., and **W. Parker Ireland** have formed the engineering firm of Tillinghast and Ireland, Consulting and Constructing Engineers, with offices in the Forum Bldg., Sacramento, Calif., and the Nixon Bldg., Reno, Nev. They will specialize in irrigation, drainage, hydraulic and sanitary engineering. Mr. Tillinghast has been in the employ of the United States Reclamation Service for the past ten years in charge of construction of irrigation works, the most recent of which is the Lahontan dam of the Truckee-Carson Project in Nevada. Mr. Ireland was formerly in the Water Department of Chicago, later Hydraulic Engineer with the Chicago, Milwaukee & Puget Sound Ry., and until recently was Constructing Engineer with the State Engineering Department of California.

Matthew C. Brush has been elected President of the Boston Elevated Railway Co., succeeding William A. Bancroft. Mr. Brush has been Vice-President of the company since 1910. He is a native of Minnesota and was educated at the Armour Institute of Technology, Chicago, and Massachusetts Institute of Technology at Boston, where he was graduated in mechanical engineering in 1901. His first engineering experience was with the motive power department of the Union Pacific R.R. at Omaha, Neb. Later he was with the Chicago, Rock Island & Pacific Ry. From 1903 to 1909 he was Vice-President and General Manager of the properties operated by the Boston Suburban Electric Co. From 1909 to 1910 he was General Manager of the Jamestown, Chautauqua & Lake Erie R.R. and the Chautauqua Steamship Co.

William L. Darling, M. Am. Soc. C. E., Chief Engineer of the Northern Pacific Ry. for many years, has resigned, effective Oct. 1. He was graduated from Worcester Polytechnic Institute in 1877 and entered the railway service in 1879 as a Resident Engineer on the old Northern Pacific R.R. Later he was Locating Engineer of the Chicago, Burlington & Quincy R.R. and of the Florida Ry. In 1885 he had charge of much construction work as Engineer in charge of terminals of the Chicago, Burlington & Northern R.R. He was Assistant Engineer and Chief Engineer of lines which subsequently became part of the Northern Pacific Ry. until 1898, when he became Assistant Chief Engineer of the entire system. He was Chief Engineer from 1901 to 1903, when he resigned to become Chief Engineer of the Rock Island System, but in 1905 was recalled to his old position with the Northern Pacific and took charge of many extensions in the Northwest.

OBITUARY

Eckley B. Coxe, Jr., of Hazleton, Penn., a member of a pioneer family of anthracite coal operators, died Sept. 20, aged 43 years. He was known to engineering students and instructors as the translator of Weisbach's "Mechanics." In recent years he was much interested in Egyptian archaeological explorations.

Frank E. Shedd, M. Am. Soc. C. E., a mill and hydraulic engineer and vice-president of Lockwood, Greene & Co., of Boston, died at his home in Dorchester, Mass., on Sept. 22. He was born in Sharon, N. H., in 1856 and was graduated from Dartmouth College in 1880. Mr. Shedd was a member of the American Society of Mechanical Engineers and of the Boston Society of Civil Engineers.

Fremont Wilson, a civil engineer of Marion, Ind., was killed in that city Sept. 15 as the result of a collision between an interurban electric car and the automobile in which he was riding. He was at one time engineer in charge of construction of the Chicago, Indiana & Eastern Ry., from Muncie, Ind. to Converse (now a part of the Pennsylvania System), and he was County Surveyor of Grant County from 1908 to 1912. At the time of his death he was in charge of some road construction near Marion. He is survived by a widow and three children.

ENGINEERING SOCIETIES

AMERICAN CHEMICAL SOCIETY.
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

EFFICIENCY SOCIETY OF AMERICA.
Oct. 7-9. Annual meeting at New York City. Secy., G. E. Burroughs, Pittsburgh, Penn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickly, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The American Society of Civil Engineers will hold its annual meeting, Jan. 17, in the Society House, 220 W. 57th St., New York City.

The Canadian Society of Civil Engineers will hold its annual meeting the third week in January. The secretary is Prof. C. H. McLeod, 176 Mansfield St., Montreal.

The New England Water-Works Association will hold its annual meeting in Boston on the second Wednesday of January. The secretary is Willard Kent, Narragansett Pier, R. I.

The Society of Constructors of Federal Buildings will hold its seventh annual convention in Washington, D. C., Jan. 15 to 18. The secretary is Charles Reed Marsh, Brattleboro, Vt.

The National Commercial Gas Association will hold its annual convention Nov. 13 to 18, in Atlantic City at the Hotel Traymore. The secretary is Louis Stotz, 61 Broadway, New York City.

The Society for Street Cleaning and Refuse Disposal will hold an annual convention in New York City, Oct. 13 and 14, at the New York Department of Street Cleaning, on 20th St. near 6th Ave.

The American Foundrymen's Association and the American Institute of Metals held a joint annual meeting in Cleveland, beginning Sept. 13, and a very large machinery exhibition in Wigmore coliseum.

The Compressed Gas Manufacturers' Association will hold its annual meeting in New York City at 120 Broadway, on Monday, Jan. 15. The secretary is Otto S. King 120 Broadway, New York City.

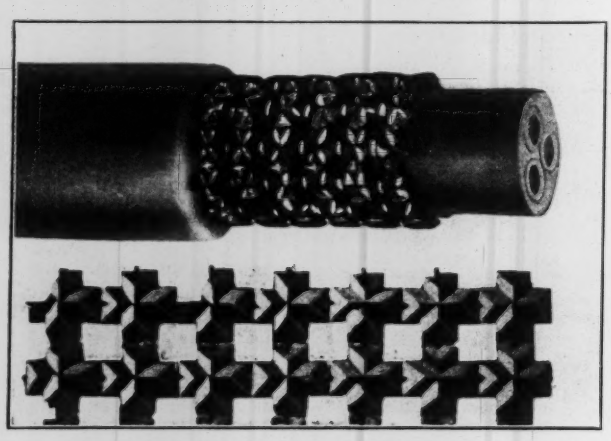
The Society of Municipal Improvements will hold its annual convention in Newark, N. J., Oct. 9 to 13, which will make it possible for the members of this society and of the Society for Street Cleaning and Refuse Disposal to take in both conventions with the maximum of convenience.

The American Public Health Association will hold its annual meeting in Cincinnati, Oct. 24 to 27. Two of the papers are: "What Are the Limitations of Public Health Administration" and "Public Health Administration on the District Plan; an Experiment by the New York City Department of Health." The secretary of the society is Prof. Selskar M. Gunn, while the chairman of the Public Health Administration section is Dr. G. W. Goler, Rochester, N. Y.

Appliances and Materials

Composite Metal Lath Formed of Wire Cloth and Clay

One of the latest additions to the field of fireproof or fire-resistive walls is a composite metal lath, consisting of annealed wire cloth on which is pressed a coating of brick clay. This arrangement provides a plaster base that has considerable solidity, yet at the same time possesses a certain amount of flexibility. The latter quality is emphasized in the lower view, showing this lath construction bent around



THE COMPOSITE LATH AND ITS APPLICATION TO ELECTRIC CABLES

an electric cable, which it is intended to fireproof. After being bent around the cable, the metal lath is covered with cement mortar, as shown.

Another application is the lining of forms, where the concrete is subsequently to be covered with plaster or tile. On removing the forms there is a plastered surface, satisfactory for bonding.

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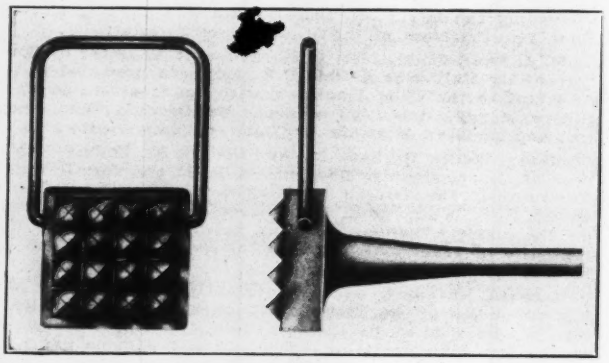
Outdoor Meter Station for High-Tension Lines

On account of the growing number of small high-tension branches on electric transmission lines—without substations—an outdoor high-tension metering station has been developed by the Westinghouse Electric and Manufacturing Co. So far the equipment has been made for 60-cycle polyphase service—not over 200 amp. and above 11,000 volts.

Each equipment consists of a standard polyphase watt-hour meter, two current transformers, a polyphase voltage transformer and three choke coils, all inclosed in a sheet-steel case with cast-iron cover supporting three high-tension outdoor type terminals. The sheet-steel case is subdivided into two compartments, one of which is filled with oil in which the transformers and choke coils are immersed, while the other serves to inclose the meter and meter panel. On the meter panel are also mounted two fuses to protect the voltage circuit of the meter and two calibrating links located in the current circuit of the meter. These calibrating links consist of fuse clips with a brass tube inserted instead of fuses. The meter may be read or checked upon opening the hinged door which covers the entire front of the meter compartment. The arrangement is such that the entire outfit, including meter panel, can be raised out of the tank without disconnecting meter leads. Choke coils are inserted between the voltage transformer windings and the outgoing leads, to protect the transformer windings against high-frequency disturbances.

A Tool for Roughing Slippery Sidewalks

An air-operated tool has been developed for roughing stone or concrete sidewalks, the complete outfit having been put on the market by the Gardner Governor Co., of Quincy, Ill.



ROUGHING TOOL FOR SIDEWALKS

It is an ordinary plug drill fitted with a casehardened steel block with 16 sharpened raised points. The first machine of this character was recently purchased by the Brinkoetter Monumental Co., of Quincy.

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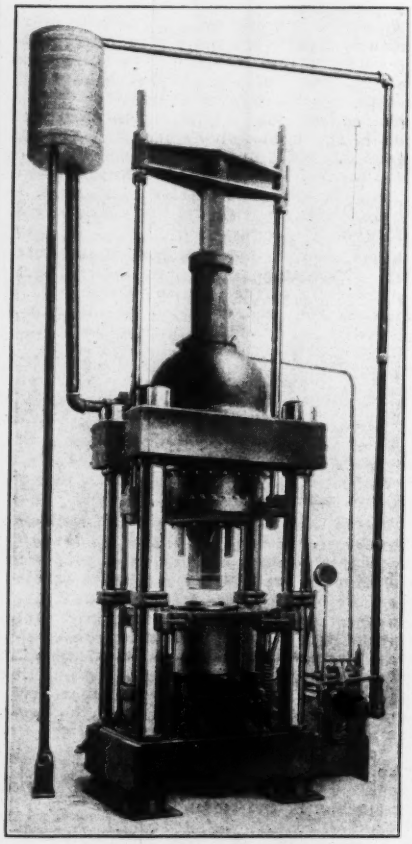
A 1,000-Ton Hydraulic Press for Briquetting Metal Waste

A large hydraulic press was recently brought out by the Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, designed to form briquettes of metal borings, turnings, etc., so that they may be remelted without the loss of valuable constituents. This process prevents oxidation and also puts the material in a convenient form for handling. The press is of the four-rod inverted-cylinder type and is built in three sizes and pressure capacities — 1,000 tons, 750 tons and 300 tons. The accompanying view shows the 1,000-ton press.



A 1,000-TON PRESS FOR BRIQUETTING METAL SCRAP

The briquette is made as follows: The material is placed in a floating mold supported by four springs. When the pressure is applied from above, the friction of the material of the sides of the mold causes it to flow down over a stationary plunger that projects into the mold from below. Pressure is thus exerted on the bottom as well as on the top of the material, and a briquette of uniform density is obtained. After being formed, the briquette is ejected from the mold by the pressure of the main ram applied upon the briquette with the lower plunger removed. The briquette falls through to the base of the press, whence it is removed by a conveyor installed by the customer.